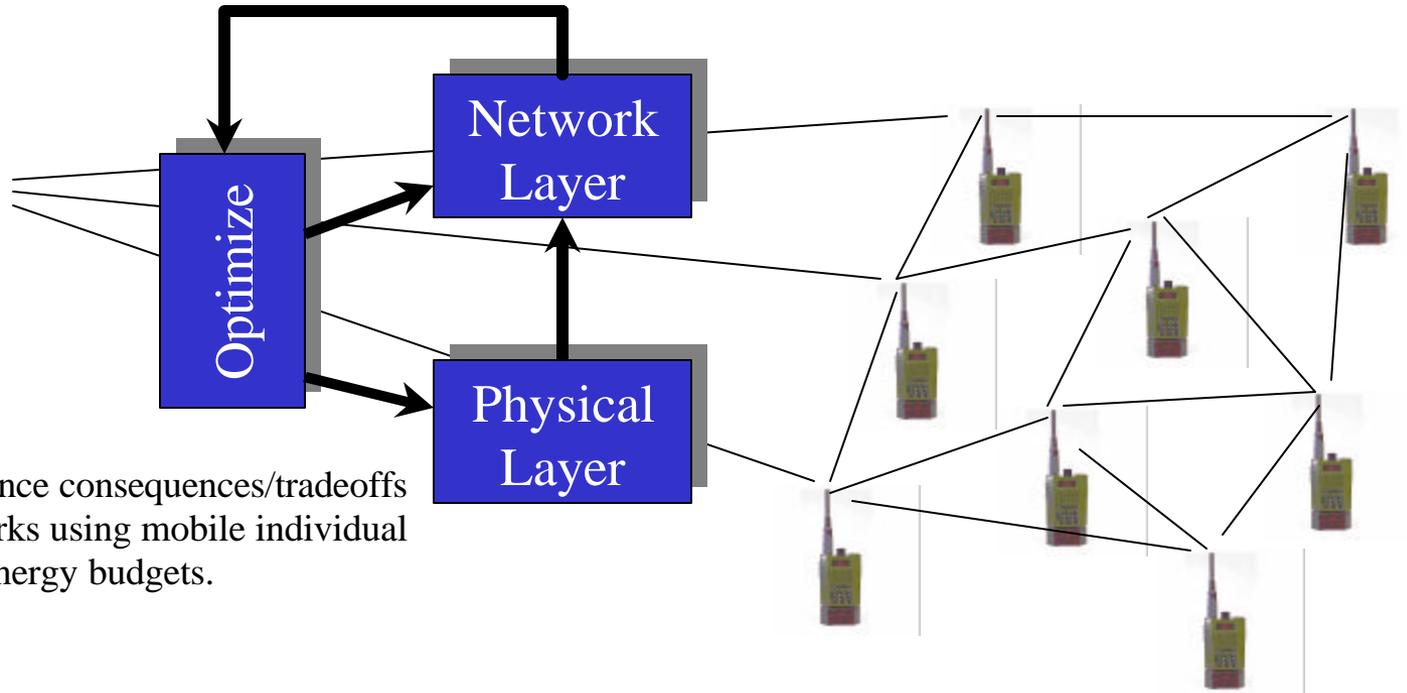


Energy Efficient Wireless Networking



Objective

To research the performance consequences/tradeoffs of designing radio networks using mobile individual nodes possessing finite energy budgets.

Approach

The approach will build on, and address basic issues not addressed under prior DoD MURI (Low Energy Electronics for Mobile Platforms) including timeliness, scenario dependant robustness and sensitivity, multi-objective optimization, feedback between receiver and transmitter, asymmetric nodes, event driven network loading, dynamic network performance objectives, interference from other users, and medium access control (MAC) protocol design.

Payoff

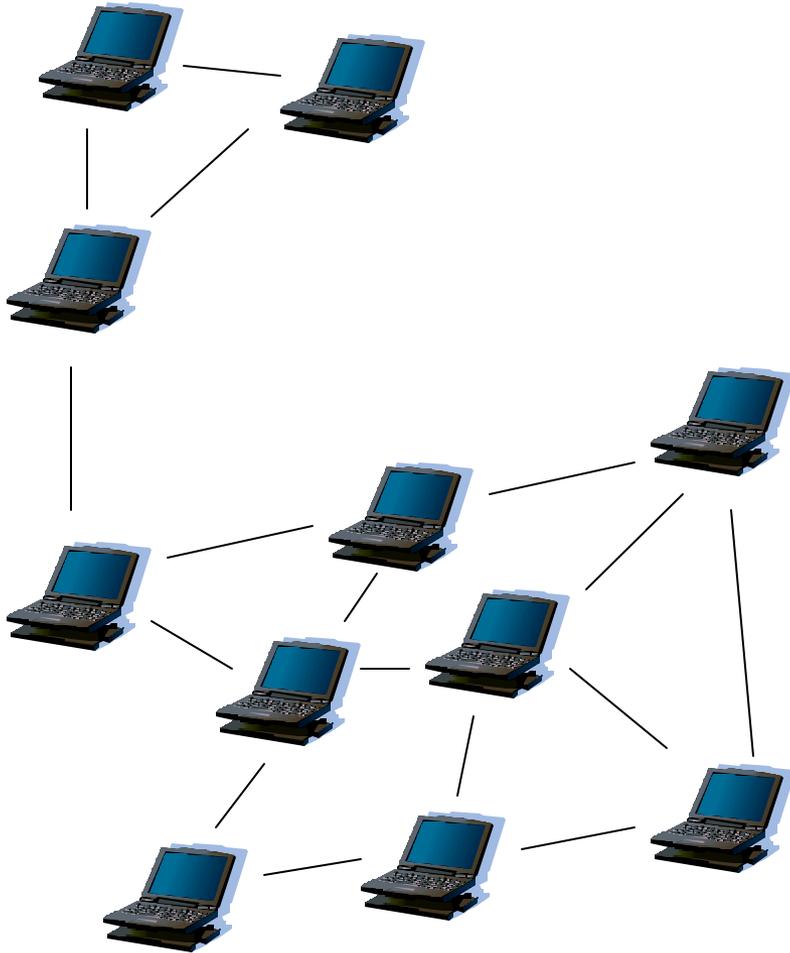
A more realistic assessment of the operational consequences of network design decisions for networks which must function under practical operational constraints.

Performer

University of Michigan



Game Theoretic Analysis of Radio Resource Management for Ad-hoc Networks



Objective

To provide the basis for a more realistic approach to analytical characterization of radio communication networks in an expeditionary warfare environment, i.e. each node acting to optimize performance of its assigned duties.

Approach

To investigate the application of game theory to the analysis and resource management of wireless ad-hoc networks

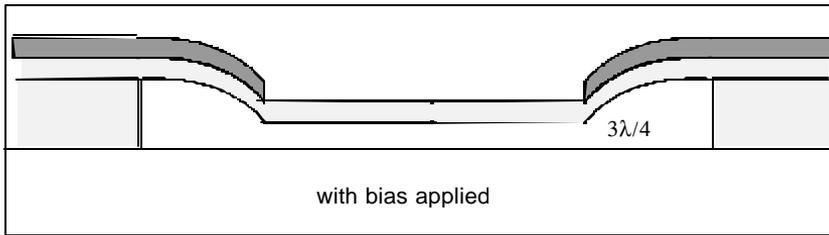
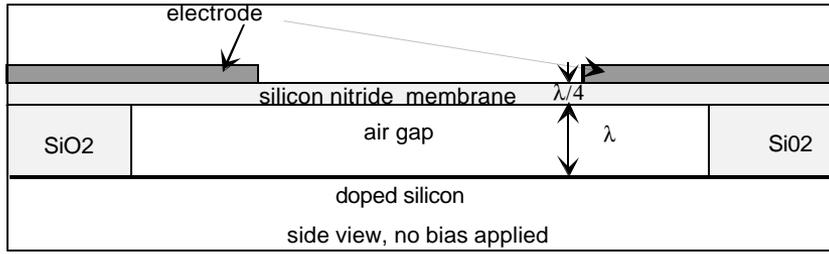
Payoff

The ability to evaluate (and possibly enhance) the performance of radio communication network architectures and protocols in realistic resource limited environments

Performer

Virginia Polytechnic Institute & State University

MEMS Based Athermal Modulating Retroreflector



Objective

To explore the feasibility of creating a simple robust device for modulating reflected optical energy for purposes of communication and/or sensing

Approach

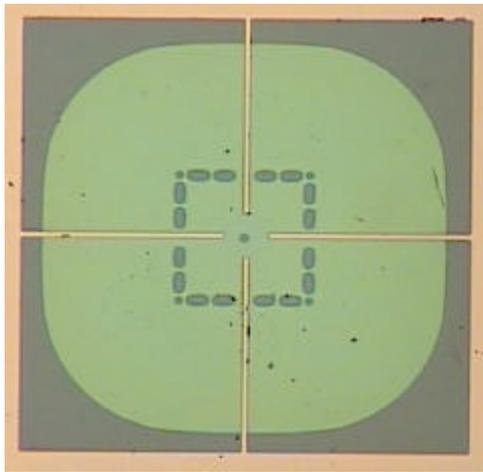
Utilization of a flexible silicon nitride membrane to modulate the resonant/reflective behavior of a layered structure (placed over a corner reflector).

Payoff

- Extremely low power line-of-sight high-data-rate laser communications for sensors or individuals with very limited energy.
- Operates over wide temperature range.

Performer

University of Delaware

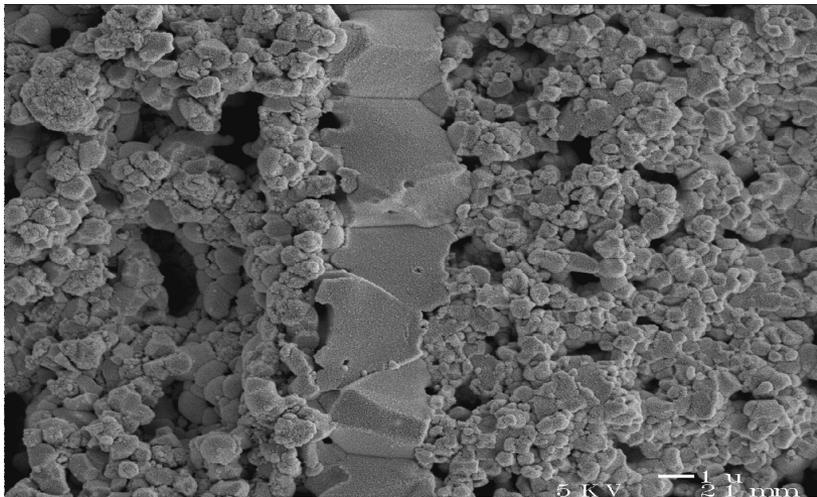


Microphotograph of first device (400 um across)



Development of Fuel Cells for the Direct Electrochemical Oxidation of Strategic Fuels

SEM Cross Section of a Solid Oxide Fuel Cell



Anode

**Electrolyte
~ 3 mm thick**

Cathode

Objective

Investigate direct oxidation (without reforming) of logistic fuels such as JP-8 in a solid oxide fuel cell

Approach

- 1) New techniques for in-situ monitoring of the direct oxidation process
- 2) Improve control of anode microstructure and composition
- 3) More precise modeling of anode to incorporate surface reactivity
- 4) Apply recently developed anode synthesis techniques to improved cathodes

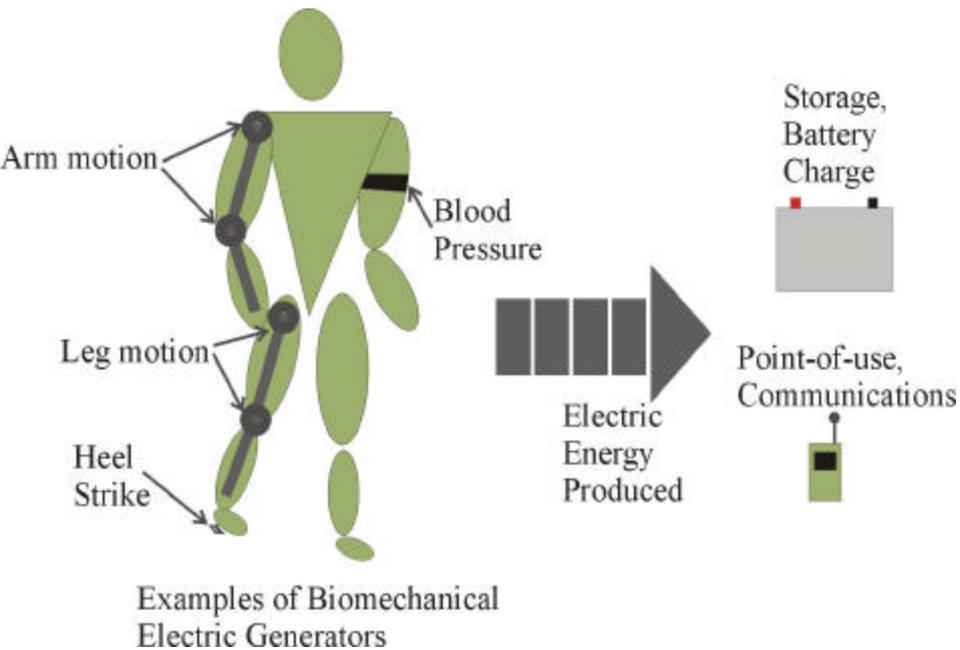
Payoff

Fuel cells which can directly oxidize common logistic fuels without reforming or with reduced reforming requirements. (Sulfur contamination would still have to be addressed.)

Performer

University of Pennsylvania

Biomechanical Energy Conversion



Objective

To explore the potential for harnessing human energy to provide supplemental or back-up electrical energy for individual Marines

Approach

- Biomechanical Energy Assessment
- Electromechanics
- Power Electronics

Payoff

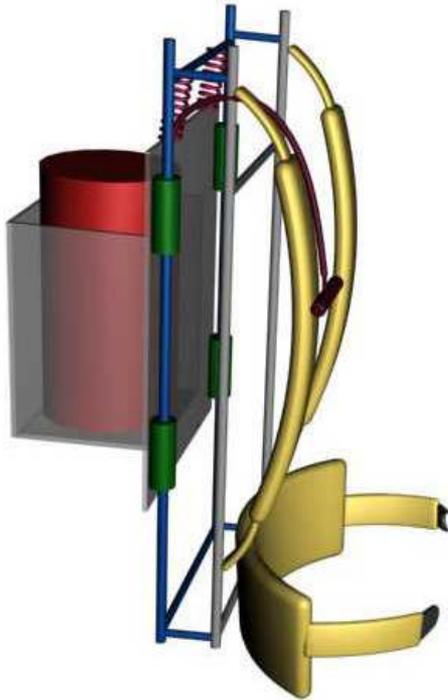
The capability to minimally operate individual electric devices in emergency situations

Performer

University of Illinois, Urbana Champaign



Electrical Energy Harvesting



Experimental device for investigating displacements and forces between backpack and individual

Objective

To optimization of electrostrictive materials for the generation of electrical energy from human motion

Approach

Electrostrictive polymers/composites will be custom designed to provide optimal matching with both the forces and displacements associated with various types of natural human motion

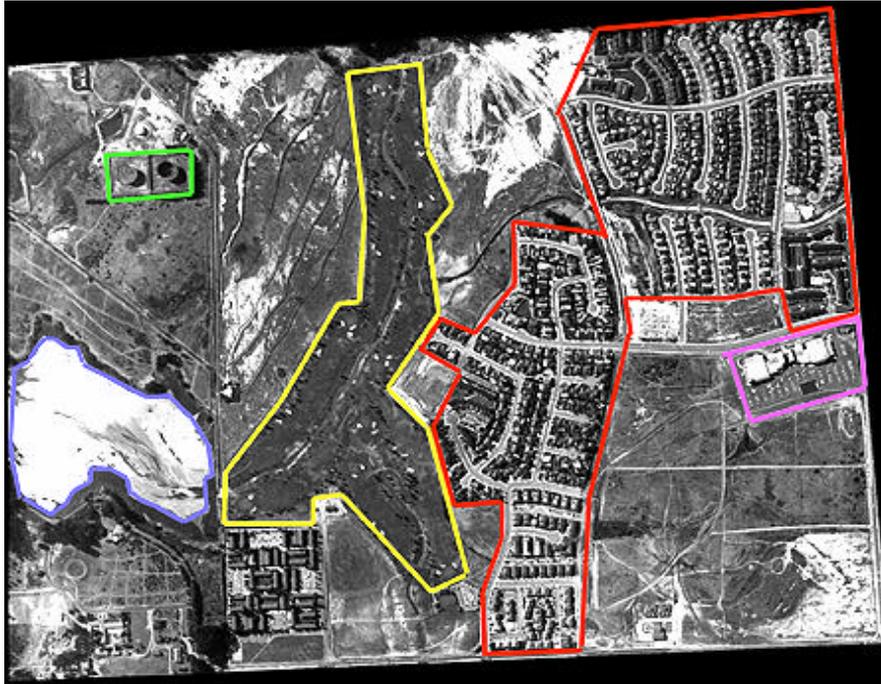
Payoff

Supplementary and/or emergency electrical energy for individual Marines.

Performer

Pennsylvania State University & University of Pennsylvania

Image Registration and Segmentation



Example of Object Based Segmentation

Objective

Explore the computational advantages of a combined segmentation and registration approach to complex image processing.

Approach

Combining recent developments in the areas of image registration and knowledge driven segmentation (specifically, point-matching condition theory with affine-invariant regions)

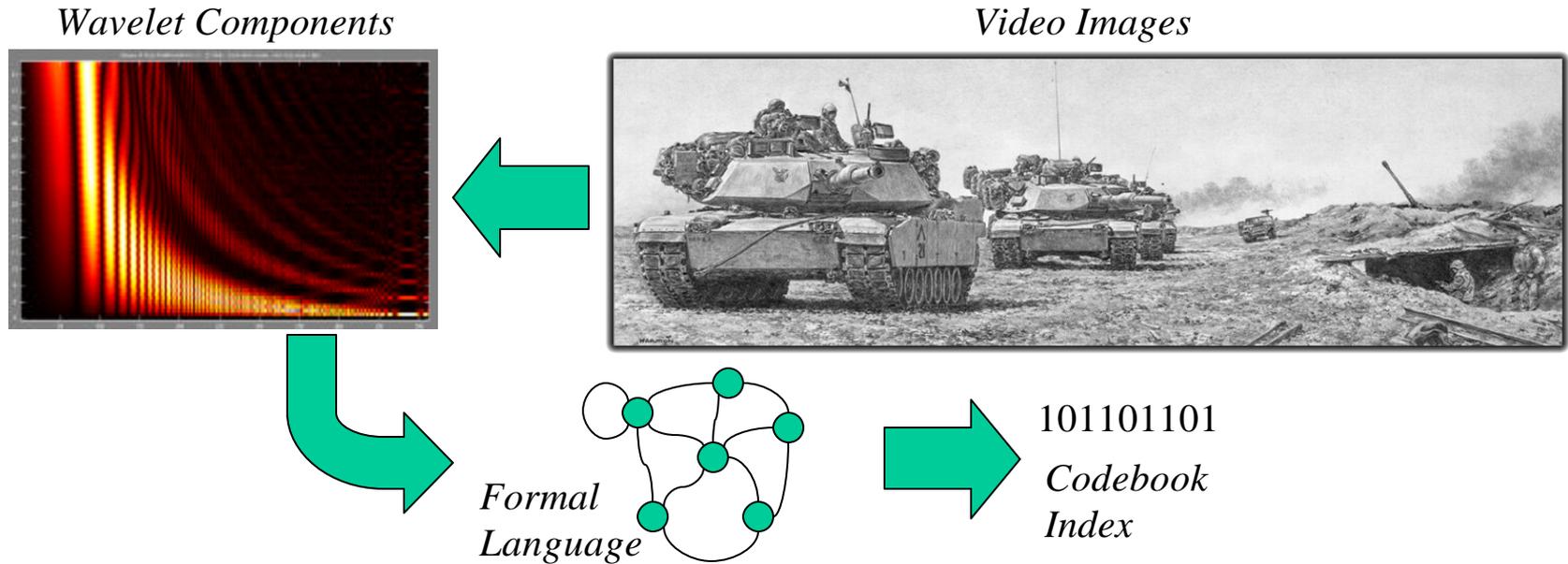
Payoff

Enhanced computational efficiency for applications such as image to map registration, change detection, tracking, 3D scene reconstruction (wide baseline dilemma), fast video mosaicing and management of large video databases.

Investigator

University of California, Santa Barbara

Semantic Source Coding



Objective Mitigate power constraints and bandwidth limitations on mobile sensor networks by devising knowledge-based methods for efficient video data compression and coding.

Approach Raw sensor data is processed into semantic information with flexible resolution, related to battlefield objects and their behaviors. Increasing levels of compression are based on wavelets, formal languages and codebooks.

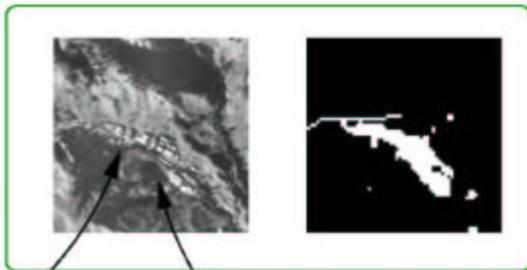
Payoff Greater situational awareness within bandwidth and energy constraints

Principal Investigator Dr. Shashi Phoha, Applied Research Laboratory at Penn State University

Status New Start

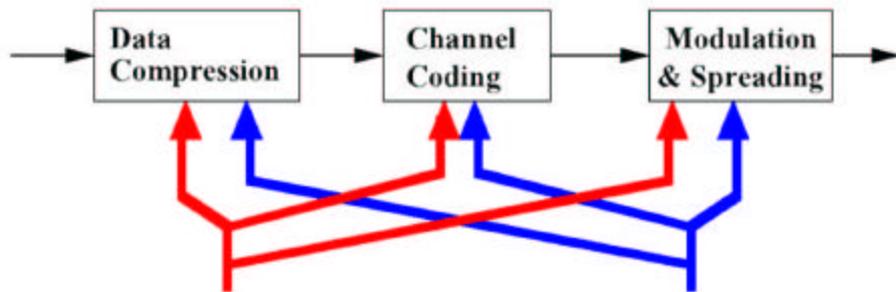
Region Based Image Compression

REGION BASED IMAGE COMPRESSION



*Higher Quality
for the
Important
Parts*

*More Error Protection
for the Important Parts*



*Efficient Allocation
of Bandwidth Among
the 3 Components*

*Efficient Allocation
of Energy Among
the 3 components*

Objective

To investigate region based image and video compression techniques as they interact with the physical layer (bandwidth and energy constraints)

Approach

- Region based compression techniques for applying higher quality/more error resilient coding to areas of interest
- Optimal bandwidth allocation among image coding, channel coding and spreading in a CDMA system
- Modifying image compression algorithms to optimize battery discharge profile

Payoff

Maximization of the amount of imagery information that can be transmitted within a finite (battery powered) energy budget

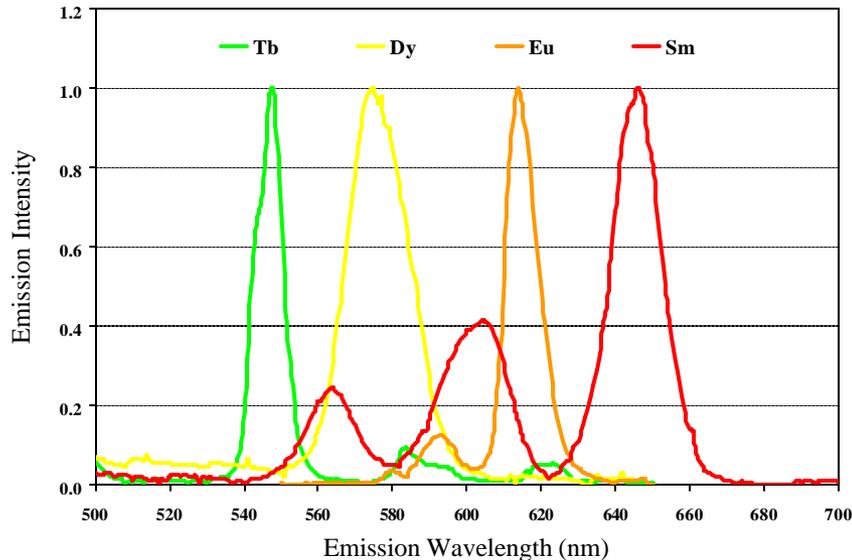
Principal Investigator

Dr. Pamela Cosman, UC San Diego



Fluorescent Rare Earth Chelates as Marking Materials

Composite Emission Spectra



Composite fluorescence spectrum showing narrow band fluorescent emissions from chelated compounds containing terbium, dysprosium, europium, and samarium.

Objective

To explore and expand the feasibility of using chelated rare earth compounds containing chromophoric ligands as fluorescent marker materials

Approach

- Tailored photostability for time registration
- New chelating agents/chromophoric ligands for near-IR emission
- Multiple narrow band emission peaks for spectral coding

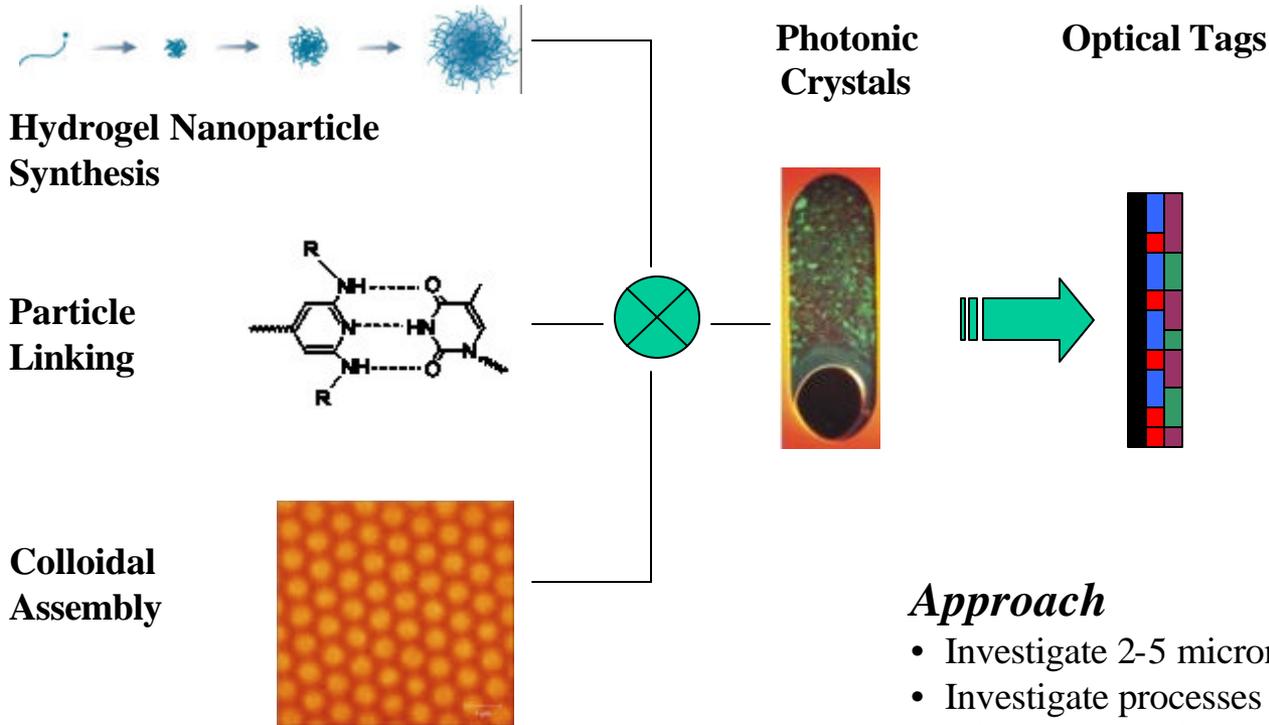
Payoff

Options for marking locations with time registered indicators of traffic

Performer

Naval Air Warfare Center, Weapons Division

Microgels for Optical Tagging



Performer

Georgia Institute of Technology

Objective

To investigate the potential of microgel-based synthesis techniques to optical tagging

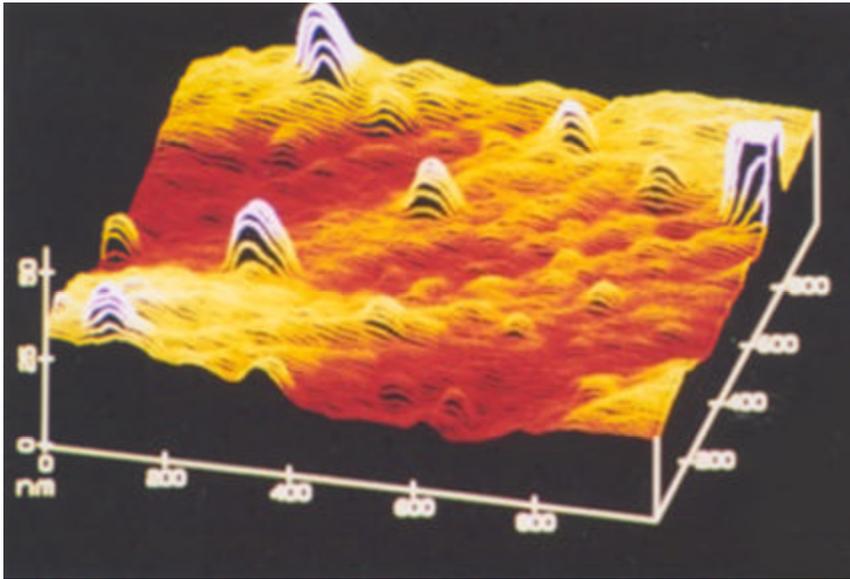
Approach

- Investigate 2-5 micron particle synthesis
- Investigate processes for stabilizing particles into a colloidal crystal structure
- Combine results of previous steps for creating arrayed/multi-layered films
- Investigate environmental robustness issues

Payoff

Alternative approach for identification of individuals/objects in a confused/urban environment

AFM Determination of Radiation Exposure



An AFM image of commercial grade polycarbonate sheet irradiated with gamma rays, showing 10-30 nm high hills produced from damage. Common plastics are good indicators of radiation.

Objective

To investigate nanometer surface damage in materials exposed to ionizing radiation

Approach

Atomic Force Microscopy (AFM) is used to directly image the changes in material surface morphology (subtle radiation damage). This exploits the ability of many natural and manmade materials to function as serendipitous permanently-recording radiation dosimeters.

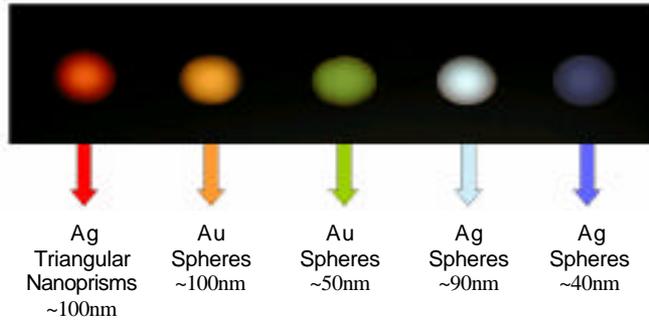
Payoff

- To be able to determine which individuals, vehicles, shipping containers, locations, etc. may have ever handled nuclear materials
- Serendipitous radiation dosimetry (without pre-positioned dosimeters)
- More reliable and lower cost radiation dosimetry

Performer

Naval Surface Warfare Center, Carderock Division

Photo-synthesis of Metal Nanostructures



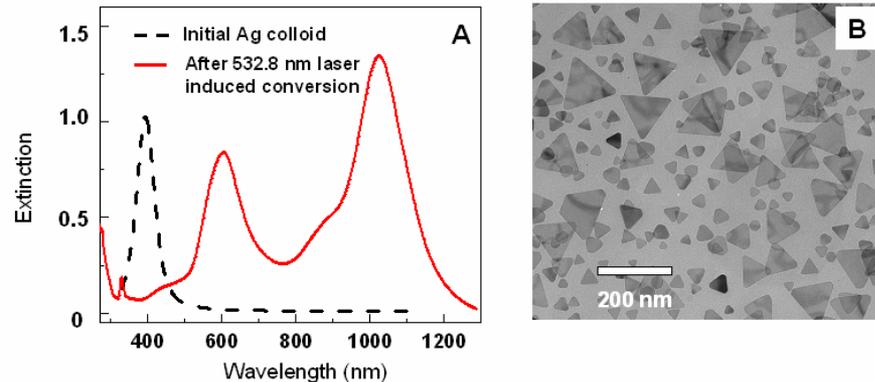
Rayleigh light scattering of particles deposited on a microscope slide illuminated with a tungsten source

Objective to study how one can use light to effect and direct metal nanoparticle growth.

Approach investigate a combination of photomediated conversion with wet chemical techniques to produce nanoprismatic shapes with novel morphologies and compositions.

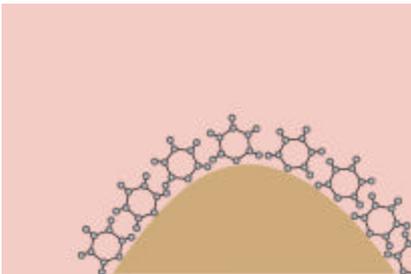
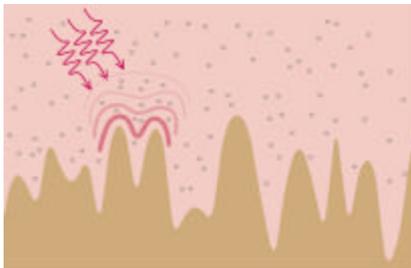
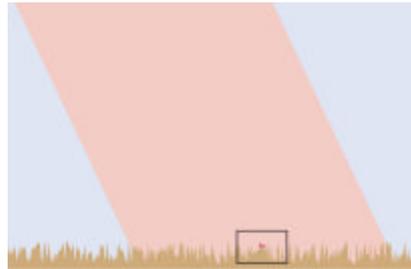
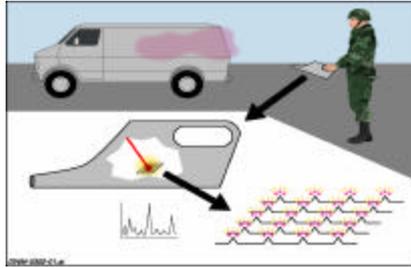
Payoff techniques for fabrication of novel multi-spectrally coded marking materials

Performer
Northwestern University



(A) UV-VIS-NIR spectra of a silver colloid (4.8 ± 1.1 nm) before (dash line) and after (solid line) laser (533 nm, Nd:YAG) induced conversion. (B) TEM image of the resulting nanoprisms shows a bimodal size distribution.

SERS for Chemical Marker Detection



Objective

To investigate the possibility of fabricating Surface Enhanced Raman Spectroscopy (SERS) detector surfaces to enhance detection of specific substances

Approach

- Nanofabrication of SERS sensor surfaces to optimize sensitivity to specific marker substances
- Modification/selection of specific marker substances to enhance interaction with SERS sensor surface

Payoff

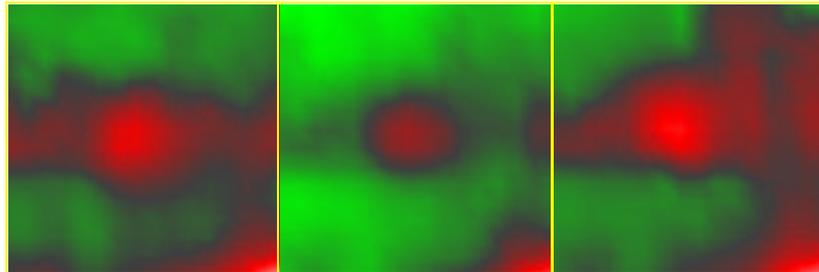
The ability to detect small quantities of specific materials used for cooperative or non-cooperative marking purposes

Performer

Pennsylvania State University, Applied Research Laboratory

False Indicators to Acoustic/ Seismic Buried Landmine Detection

Field Test Observations

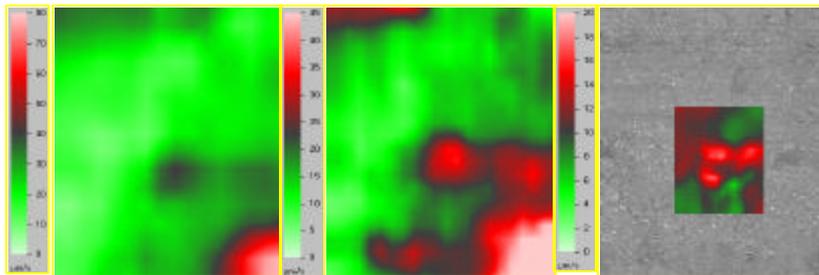


110 -130 Hz

120 -140 Hz

130 -150 Hz

Mine target as a function of excitation frequency



114 points/m²

215 points/m²

1024 points/m²

False target as a function of spatial resolution

Objective

Enhanced understanding of the mechanisms responsible for false indications in acoustic/seismic landmine detection

Approach

- Statistical analysis of field data
- Investigate effects of soil property
- Investigate nonlinear coupling effects

Payoff

- Possibly more precise target classification, or...
- Quantification of the limits to correct target classification using acoustic-to-seismic mine detection

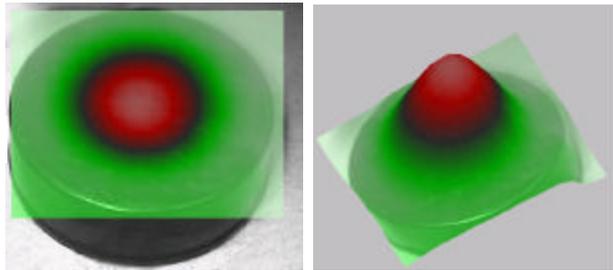
Performer

University of Mississippi.

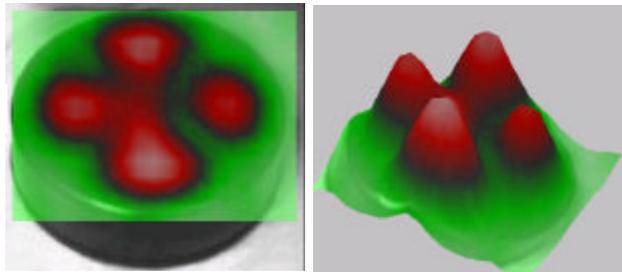
Seismic Detection of Buried Landmines

MINE VIBRATION MODES

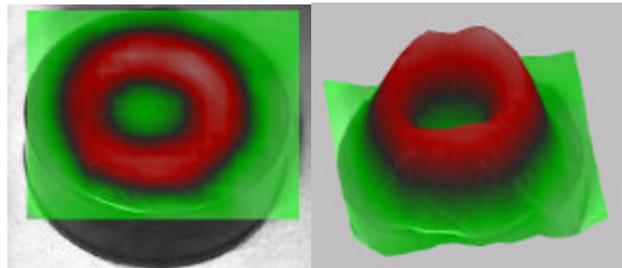
182 Hz



420 Hz



650 Hz



Objective

Investigate soil-mine seismic energy interaction

Approach

- Structural dynamics of mines
- Mechanisms of vibration excitation
- Projection of mine vibration modes to soil surface
- Nonlinear interactions at the soil mine interface

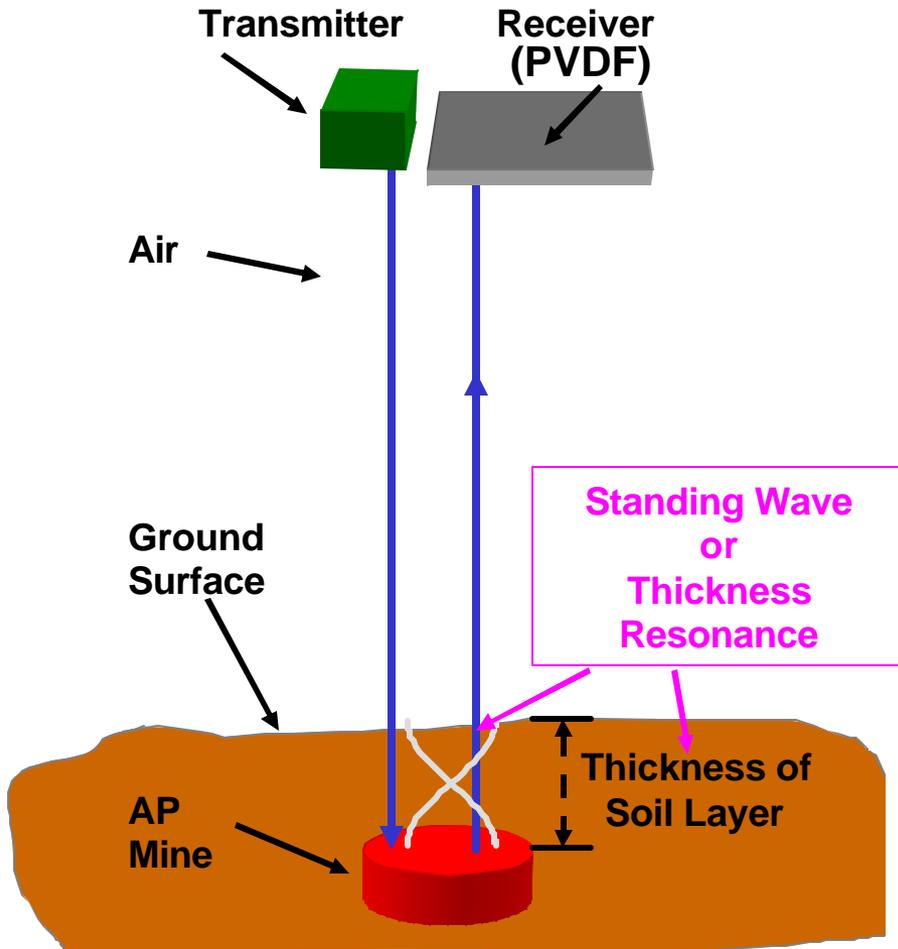
Payoff

Quantification of the limits and variability of vibration interaction between mine and soil

Performer

Stevens Institute of Technology

Acoustic Detection of Landmines



Objective

Quantification of the key parameters and performance thresholds required for acoustic detection of buried mines

Approach

Experimental propagation and resonance measurements (with and without air-gap)

Payoff

Quantification of the upper frequency limits to acoustic mine detection

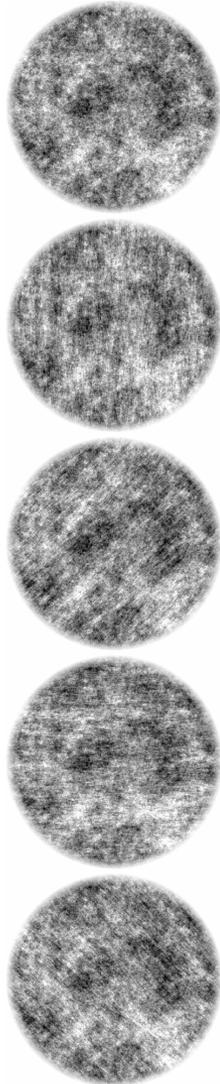
Principal Investigators

Naval Research Laboratory



Human Perception of Natural Scenes

The top stimulus patch shows a noise pattern with no oriented component for comparison purposes. Underneath the un-oriented pattern is an example of the stimuli used shown at the four orientations tested, each with an oriented increment of an identical amount. Typical observers find the oriented component to be most salient when at the oblique orientations and least salient at the horizontal orientation.



Objective

To investigate the effects of spatial orientation biases on human perception in the context of realistic visual clutter

Approach

Expand on recent observations that the effects of spatial orientation human visual perception in the presence of realistic clutter are very different than previously documented studies (performed in the absence of realistic clutter).

Payoff

The ability to optimize the output of vision enhancement devices so as to cooperate with the attributes of natural human vision.

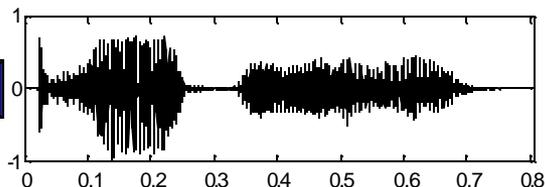
Performer

University of Louisville

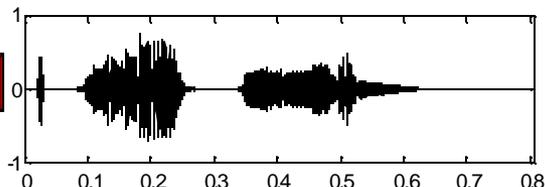
Transition Speech Waveforms

Estimates of quasi-steady-state and transition components of speech – preliminary work

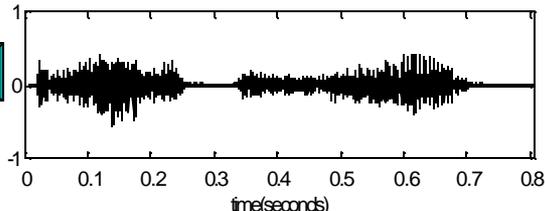
Original speech



"Quasi-Steady-state"



"Transition"



"cowboy" (Northwestern University word list)

Contemporary Perspectives in Hearing Assessment,
by Frank E. Musiek and William F. Rintelmann,
Allyn and Bacon, 1999

Objective

To enhance the efficiency of RF voice communications

Approach

Study approaches and effects for isolation of transition content (between phonemes) from steady-state content (phonemes)

Payoff

- More intelligible RF communications in noisy environments
- More efficient voice digitization (using bits where they do the most good)
- More intelligible voice comms with temporarily impaired hearing

Performer

University of Pittsburgh

1,3 Cycloaddition (Triazole Cure)



Objectives

- To understand the cross linking polymerization chemistry and resulting physical/mechanical properties for 1,3 cycloaddition triazole ring formation.
- To produce new binders for explosives and propellants composed of azido-containing oligomers crosslinked by triazole cure.

Approach

- Model triazole cure kinetics
- Establish structure-activity/mechanical property correlation between polyacetylene cure agents and polyazido binder structure.
- Fabricate and characterize small propellant samples.

Payoff

Explosive binders that are cure-compatible with higher energy ingredients, facilitating lighter weight rocket motors and warheads

Performer

University of Florida