NDIA Poster Presentations

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Wearable Sensors for Human Health and Performance Monitoring

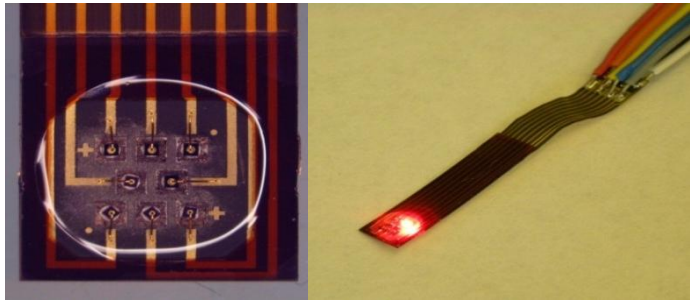
Azar Alizadeh, et al. GE Global Research alizadeh@ge.com

Research Objective(s)

- Continuous monitoring of physiological parameters may significantly improve human performance in civilian and military operations.
- Ubiquitous deployment will require low cost sensors and suitable manufacturing approaches.
- This project develops and evaluates prototype multi-wavelength arrayed photoplethysmograph (PPG) devices continuous non-invasive measurements of hemodynamics.

Technical Approach

- Coarse multi-wavelength spectroscopy using multiple LEDs to measure all hemoglobin fractions
- Development of devices with thin flexible form factor
- Assess magnetically directed self-assembly for possible low cost manufacturing



Significant Results

- Prototype 8-LED PPG devices developed
- SpO2 measurements have been validated
- Novel magnetically directed self assembly (MDSA) process developed and simulated
- Demonstrated device positioning and electrical connection by MDSA process

DoD Relevance

- Continuous health and performance monitoring may improve warfighter effectiveness and safety
- At point of injury and/or prior to first transport, there is a need for physiological monitoring to assist in the first level of care (i.e., Buddy Care)
- Wearable sensors allow information about the state of the human into logistics & operational decisions

imagination at work

In connection with Award W81XWH-11-1-0833, the U.S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick MD 21702-5014 is the awarding and administrating acquisition office. However, the content of this information does not necessarily reflect the position or policy of the Government, and no official endorsement should be inferred.

The Significance of Language & Cultural Awareness in Sustaining US Global Leadership

Alnoor F. Alnoor • Comprehensive Language Center, Inc. • aalnoor@comprehensivelc.com

Research Objective(s)

- Identify the role of language and cultural awareness in sustaining US Global leadership
- Highlight the benefits and challenges of FMS localization in the realm of S&T Program

Technical Approach

- Analyze the state of Language and Cultural Awareness Programs in the U.S. Highlight deficiencies
- Examine the volume and role of FMS within the context of S&T Program and the relevance of Language and Culture therein

Significant Results

The three-fold growth in the FMS arena stresses the need to embrace Language and Cultural Awareness as key components of S&T and FMS Programs

DoD Relevance

- Language and Cultural Awareness are enablers of diplomacy that contribute to the U.S. Military Superiority
- Language & Culture enhance S&T and FMS and empower our allies.

MDA Prerequisite: Internet Connectivity

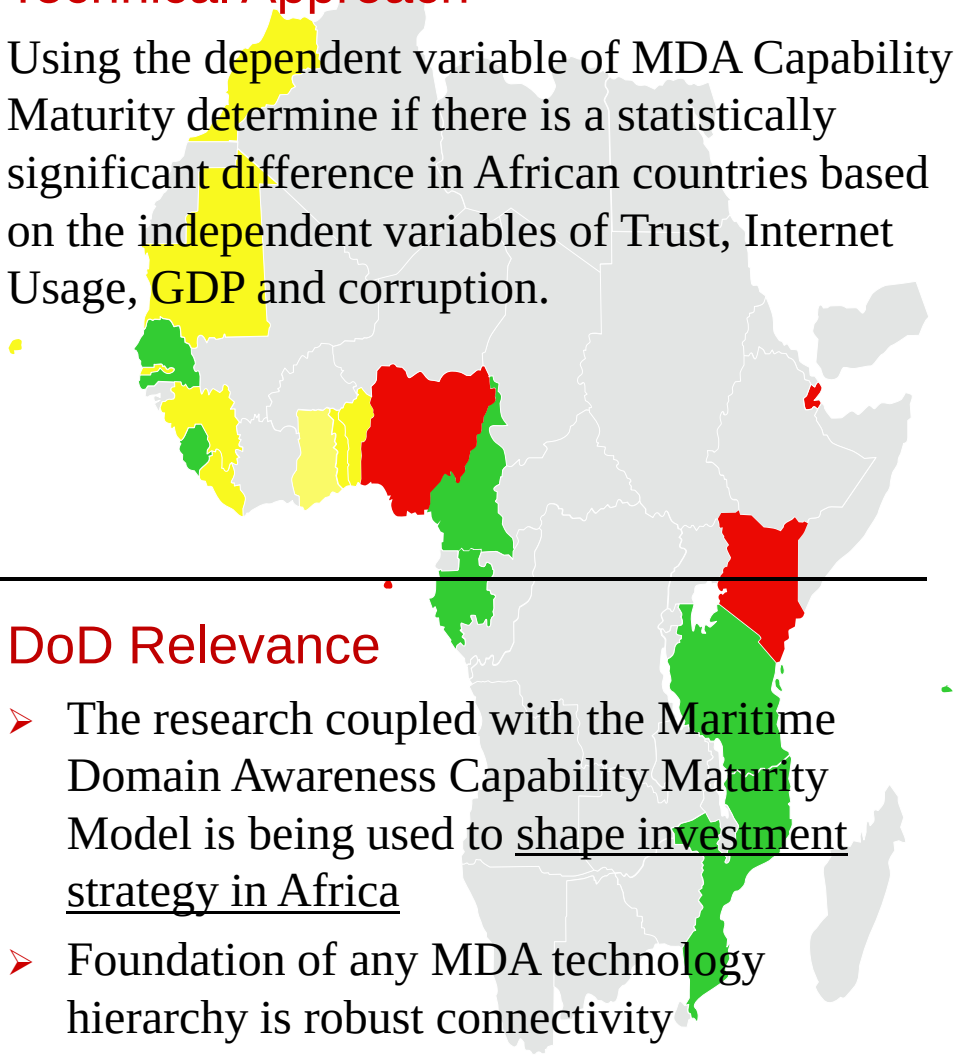
Dr. Edgar Bates (former Director Maritime Domain Awareness, Naval Forces Europe and Africa) / e.a.bates@att.net

Research Objective(s)

- Within the context of global maritime partnerships, research examined the key determinants of Trust, Globalization (Internet), Economic Wealth and Corruption in achieving effective shared situational awareness
- Research is intended to shape future engagement and investments strategies in the maritime domain.

Technical Approach

Using the dependent variable of MDA Capability Maturity determine if there is a statistically significant difference in African countries based on the independent variables of Trust, Internet Usage, GDP and corruption.



Significant Results

- Empirical observations substantiate the significance of internet connectivity
- National will difficult to measure objectively and would account for remainder of variability
- Corruption not a determinant in either direction

DoD Relevance

- The research coupled with the Maritime Domain Awareness Capability Maturity Model is being used to shape investment strategy in Africa
- Foundation of any MDA technology hierarchy is robust connectivity

Earth Technologies

David Becker, National Defense University, Center for Technology and National Security Policy, david.becker@ndu.edu

Research Objectives

- Re-evaluate DoD logistical needs concerning supply-lines for sand, gravel, cement or advanced building materials
- Reduce difficulty in delivery and costs of transportation and materials
- Cut time to acquire supplies
- Lessen maintenance requirements
- Improve ability to modify plans on-location for road and building projects

Technical Approach

- Gather data and report on current use of these technologies domestically and abroad
- Prototype testing
- Testing of multiple machines
- Follow up testing of longevity
- Preparation of guidelines on methodology, location and timing of use of these waterproofing additives and compressed earth bricks

Significant Results

- Cost reduction
- Increased efficiency of the supply lines
- Decreased reliance on outside, off-site suppliers

DoD Relevance

- Support to Humanitarian Assistance and Disaster Relief
- Defense Support to Civil Authorities
- Building Partner Capacity
- Stability, Security, Transition, and Reconstruction



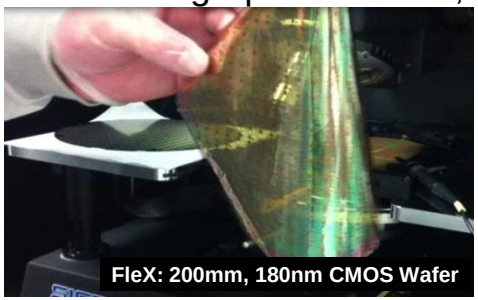


FleX™ Silicon-on-Polymer™ - Physically Flexible ICs and Flexible Hybrid Systems

Rich Chaney, American Semiconductor, Inc., richchaney@americansemi.com

Research Objective(s)

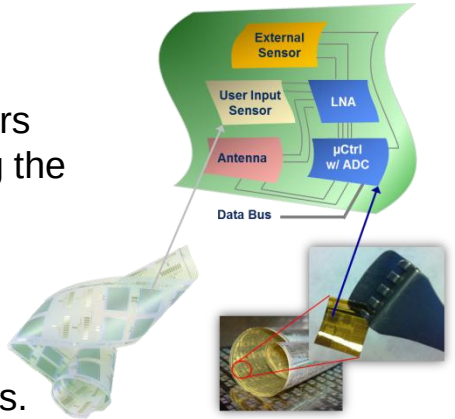
Flexible electronics have been limited by the low performance and low density of printed transistors. FleX Silicon-on-Polymer transforms standard silicon wafers and ICs into a physically flexible form factor. Flexible Hybrid Systems combine high-performance, high-density FleX ICs with low cost, large format printed electronics to realize the promise of flexible systems.



FleX: 200mm, 180nm CMOS Wafer

Technical Approach

FleX is a proprietary process to transform standard silicon wafers into flexible wafers by removing the handle silicon and applying a polymer substrate.



Flexible Hybrid Systems are created by integrating FleX ICs with printed electronics. This enables flexible systems that can leverage the large form factor and low cost benefits of printed along with the high performance of silicon-based ICs.

Significant Results

FleX ICs have been demonstrated with multiple processes. Jazz Semiconductor's process has recently been qualified for FleX and is supported and multi-project (MPW) runs. Flexible Hybrid technology has been demonstrated in Conformal Load-bearing Antenna Structures (CLAS) and has recently been awarded the FLEXI Innovation Award by FlexTech.

DoD Relevance

The ability to create flexible ICs using FleX technology and integrating FleX ICs with printed electronics using Flexible Hybrid technology enable revolutionary advances for the warfighter.

This work is complimentary to flexible displays such as the work done at the Flexible Displays Center established by the U.S. Army at Arizona State University. FleX and Flexible Hybrid are critical enablers for advances in soldier-worn electronics, CLAS, structural health monitoring, and fly-by-feel systems.

Conformal Load-bearing Antenna Structures (CLAS)

Rich Chaney, American Semiconductor, Inc., richchaney@americansemi.com

Research Objective(s)

CLAS systems are desirable as a solution to significant problems in UAV and aircraft design

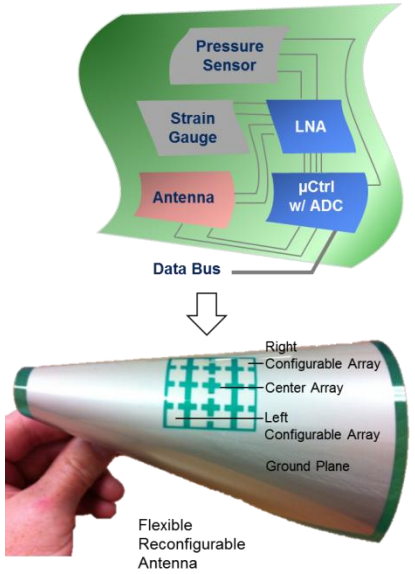
CLAS Benefits:

- Structural Integration Increases Mounting Options
  - Reduced Drag
  - Reduced Profile / Signature
  - Optimized Airframe Volume Utilization
  - Expands Retrofit Options
- Rugged & Durable
- Reduced Size, Weight, & Power

Technical Approach

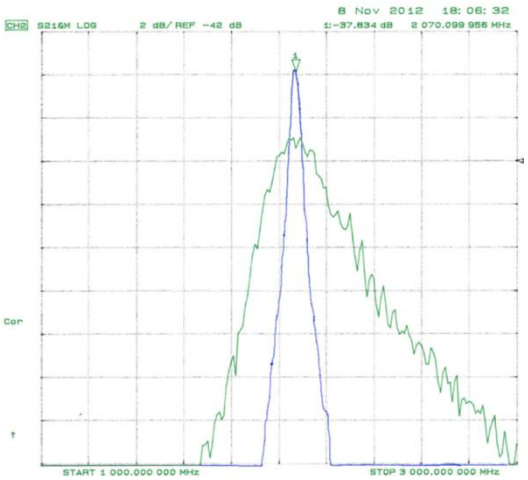
Flexible Hybrid technology is used to combine printed electronics with high performance silicon ICs to create a conformal, flexible antenna system.

The Flexible Hybrid antenna is then integrated as an intra-layer component of a structural laminate to create a CLAS.



Significant Results

In Phase I, multiple Flexible Hybrid antennas were fabricated. These antennas were then integrated into a representative composite and demonstrated as a functional prototype.



DoD Relevance

The CLAS technology presented will improve antenna performance and enable UAVs to be designed for optimal aerodynamics through elimination of protruding antennas.

In addition, CLAS technology is directly transferrable to:

- Structural Health Monitoring (aircraft, ground vehicles, buildings)
- Fly-by-Feel
- Ground-based Antennas (e.g. concealed in SUV body panels)
- Body-worn Electronics

Passive Frequency Agile Filtering for Protection Against High Power Microwave Energy

Qin Chen, GE Global Research (chenq@ge.com)

Research Objective(s)

- Provide effective protection for antenna apertures against high power microwave (HPM) energy without interrupting normal antenna operation
- Develop a passive, narrowband, tunable HPM filter with fast speed, frequency agility, and high power-handling capability

Technical Approach

- Narrowband filter based on frequency selective surfaces (FSS) with a specially designed substrate
- FSS reflection band tuned by changing the electromagnetic properties of the substrate
- Specially designed microstructure in the substrate loaded with tunable dielectric materials enables critical tuning behavior: i) driven by HPM energy; ii) fast speed; iii) wide tuning range; iv) capability of self-limiting at the HPM frequency

Significant Results

- Critical tuning characteristics verified on conceptual design using numerical simulation
- HPM-driven tuning with nanosecond-level response speed has been numerically demonstrated for the substrate
- Self-limiting tuning of the filter has been numerically demonstrated showing tuning range ($\Delta f/f$) greater than 40% of center frequency

DoD Relevance

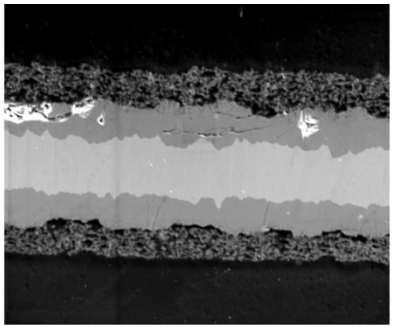
- Fast-response, passive, and effective protection against HPM energy
- Passive, self-limited tuning mechanism applicable to military RF & microwave systems, including:
  - Broadband, small aperture antennas with metamaterial as substrate
  - Broadband high impedance ground planes

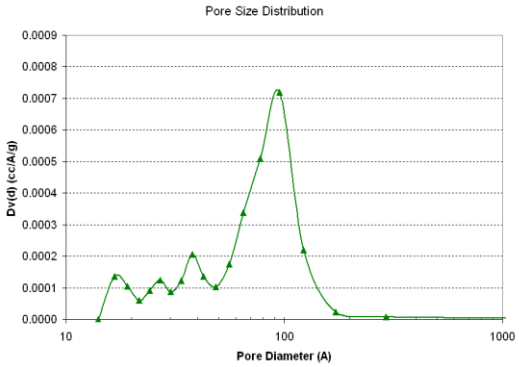
High Surface Area Nanoporous Materials for Defense Applications

Dr. Andrew Davis (andrewd@alloysurfaces.com), Dr. Rajinder Gill (rajinderg@alloysurfaces.com), Alloy Surfaces Co, Inc.

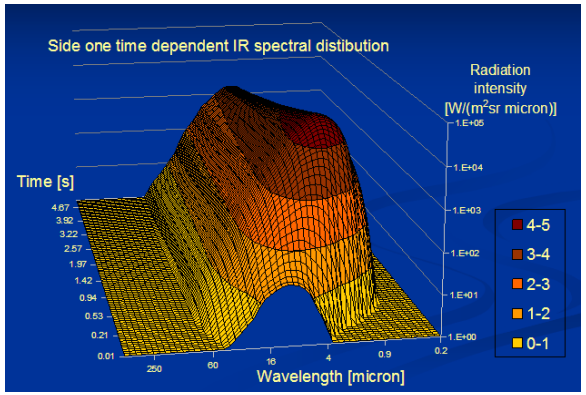
Objective: To develop pyrophoric materials tailored to emit IR radiation with predetermined characteristics

Process: Coatings are generally produced in a three step process (1) substrate coating (2) alloying & interdiffusion (3) selective extraction





Result: Capability to vary time-dependent spectral distribution of IR emission



DoD Relevance:

- Air Infrared Countermeasures
- Infrared Marker Devices
- Infrared Spotting Rounds
- Catalyst Materials

Achieving Persistent Maritime Surveillance *as a Service* for the Pacific Rim

Wilson F. Engel, III, Ph.D., Raytheon Integrated Defense Systems (Email: wilson.f.engel@raytheon.com)

Research Objective(s)

Objective: Improve transparency and intelligibility of maritime situational awareness data and information for the US and its partners in the Pacific Area of Responsibility *as a service*.

Why: Traditional collaboration protocols are ambiguous because they do not resolve linguistic and cultural differences among collaborating maritime partners.

Technical Approach

With end-users, enhance US Strategic Command's (STRATCOM's) successful User Defined Operational Picture (UDOP) with translation, predictive analytic and graphical user interface software to improve user interface options resolving linguistic and cultural differences so that the same data and information can be experienced in the manner selected by each partnering nation.

Significant Results

- The UDOP is a breakthrough in user interface technology in ways that are little understood.
- The UDOP allows individual end-users to compose their own user interfaces as they desire.
- All end users still have all data and information available, but for analysis and display their way.
- By tailoring the UDOP to the needs of end users in each Pacific partnering nation, interoperability reaches a new level of cultural accommodation.

DoD Relevance

Robust partnering with other nations of the Pacific is imperative to achieving US strategic objectives in a time of declining resources and increasing volatility. Combined command requires *both* a unified approach to command and control (C2) *and* a common understanding of the situation in spite of linguistic and cultural differences. The enhanced UDOP offers this urgently needed capability.

Beyond SDR – Software Defined Systems

Enabling Warfighters, Platforms, and Networks

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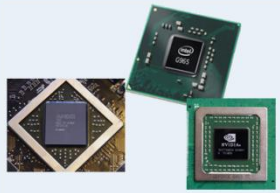
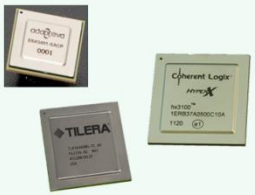
Coherent Logix™

Massively parallel embedded processors are entering the technology ecosystem



- Graphical Processing Units (GPUs)
  - AMD
  - Intel
  - nVidia

High power consumption of GPUs limit their use to rack/blade form factors



- Processor-Memory "Fabrics"
  - Adapteva: Epiphany chip
  - Coherent Logix: HyperX hx3100
  - Tilera: TilePro64

Low power consumption supports embedded processing for Software Defined Systems

Massive processing → more hardware can be replaced by software

Example:
the Software Defined Radio (SDR) approach of the Joint Tactical Radio System (JTRS)

Advantages of software over hardware

- **Software can be more easily changed than hardware**
  - Prompt adaption to changes in standards, threats, etc.
  - Custom features without requiring ASIC volumes
- **A common hardware platform can be re-used**
  - A mission-specific software load configures the hardware product
  - For different products, for different missions
- **Product differentiation is efficiently realized in software**
  - Faster response to customer's requirements
  - Market advantage over competitors

DoD relevance

- **Lower life cycle costs**
  - Lower RDT&E costs
  - Lower acquisition costs
  - Fast response to changing warfighter needs
- **Exploitation and reverse engineering is more difficult**
  - Software can be made "transient" existing (in an un-encrypted state) only during its execution cycle
  - Software can be encrypted, obfuscated, and disguised
  - Software can be zero-ized
- **Enhanced national competitiveness**
  - Faster design cycles results in lower cost products
  - Compute-intensive solutions offer technological leapfrog

A SiC Based Ultra-compact, Highly Efficient LLC Multi-Resonant Battery Charger for PEVs

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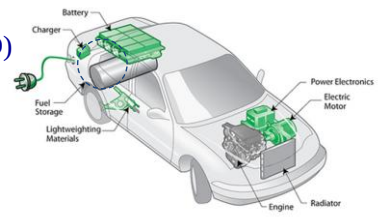
Research Objectives

New generation on-board PEV Battery Chargers

- Near unity power factor
- Low total harmonic distortion (THD)
- High power density
- Fast charging
- High conversion efficiency
- Galvanic isolation



DOE TECHNICAL TARGETS

3.3 kW Charger				
Year	Cost	Size	Weight	Efficiency
2010	$900-$1000	6-9 liters	9-12 kg	90-92 %
2015	$600	4 liters	4 kg	93 %
2022	$330	3.5 liters	3.5 kg	94 %

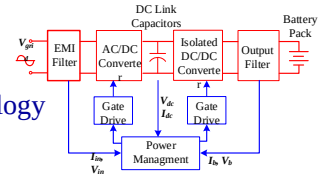
Technical Approach

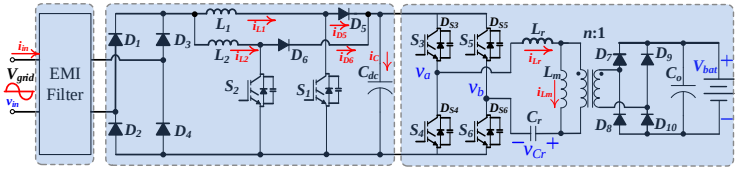
1. Front-end ac/dc conversion and power factor correction

- Interleaved boost topology in continuous conduction mode (CCM)
- Inductor ripple current cancellation and inductor size reduction
- DC link capacitor rms current reduction

2. Second stage dc/dc conversion

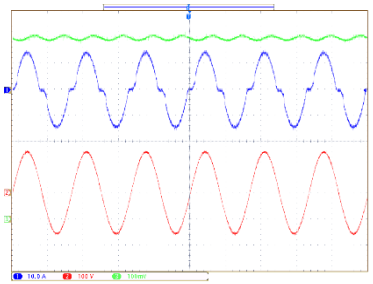
- Full bridge isolated LLC multi-resonant topology
- Frequency modulation
- Ultra-low switching losses
- Optimized conduction losses and core losses

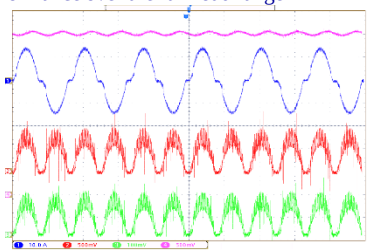


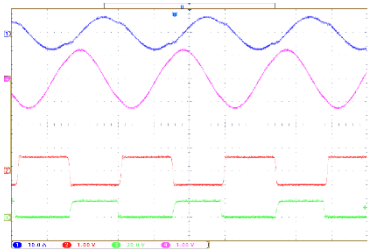


Significant Results

- Novel 1 kW interleaved full bridge LLC charger, extendable to higher power levels.
- 110 V, 60 Hz input from single phase power grid, flexible to universal grid input (85~245 V, 50~60 Hz).
- Wide output voltage range (320 V to 420 V)
- Power factor above 0.99
- THD smaller than 4% at full load
- Peak conversion efficiency of 97%, enhanced performance over the full load range







DoD Relevance

1. Environment

- Fossil fuel dependency reduction
- Low carbon emission
- Eco-friendly transportation

2. Energy

- Highly efficient energy and transportation management solution
- Energy independence and national security

3. Sustainability

- Sustainable transportation
- Renewable energy friendly

Enhanced Hybrid Battery / Ultracapacitor Energy Storage System for Next Generation Electric Transportation

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Electrical and Computer Engineering Department and Institute for Systems Research
University of Maryland, College Park, MD 20742

Research Objectives

➢ Reduce weight and volume of oversized high-power (HP) batteries.

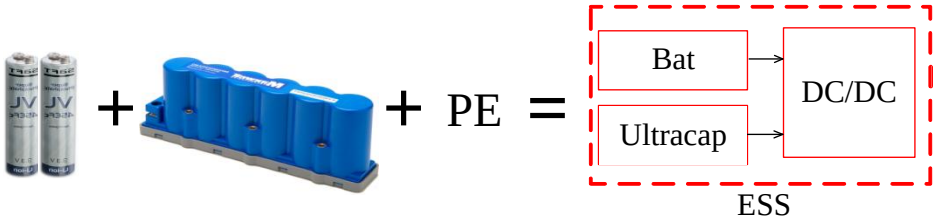
➢ Improve the lifetime of energy storage system (ESS).

➢ Enhance the performance of vehicle specially during acceleration and deceleration.

Technical Approach

➢ Effectively combine HE batteries with HP UCs using a novel bidirectional DC/DC converter.

➢ Improve performance through an innovative frequency decoupling approach.



Significant Results

Hybrid ESS composed of High-Energy (HE) battery + ultracapacitor (UC) provides:

✓52% smaller size/weight
✓60% more regenerative braking energy
✓21% less energy consumption (Wh/mile)
✓25% extended battery lifetime

DoD Relevance

➢ Military applications: Next generation electric shipboard systems, on-base electric vehicles, tactical vehicles, more electric aircraft, etc.

➢ Superior performance and significantly reduced weight



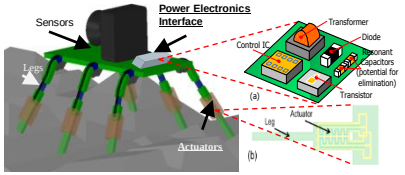
An Ultra-miniature Dual-Stage Converter for Driving Gap-closing Electrostatic Actuators in Inchworm Motor Based Jumping Microrobots

Yichao Tang, Chen Chen, and Alireza Khaligh, Institute for Systems Research, Department of Electrical and Computer Engineering
University of Maryland, College Park, MD 20742 (EML: khaligh@ece.umd.edu, URL: www.ece.umd.edu/~khaligh)

Research Objectives

Enable Power Autonomy on µRobots through:

a) Introducing novel power electronic interfaces (PEI) capable of providing drive requirements of bio-inspired µRobots
b) Investigating unique approaches to minimize PEIs, without Sacrificing efficiency
c) Developing energy recovery approaches to enhance efficiency of µRobots



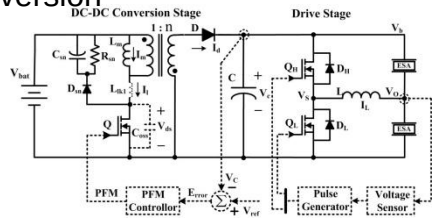
Technical Approach

Gap-closing ES Actuator

- Gap-closing structure
- Flexible driving arm
- Displacement accumulation
- High pulse voltage drive
- High frequency

PEI & Energy Management

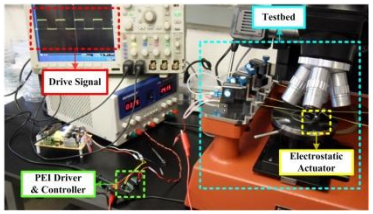
- Dual-stage DC/DC & DC/AC conversion
- High step-up voltage gain
- Component size minimization
- Unused energy recovery
- High power density



Significant Results

PEI Prototype & Testbed

- Micro-displacement observation
- Steps accumulation
- Energy recovery analysis
- Efficiency optimization

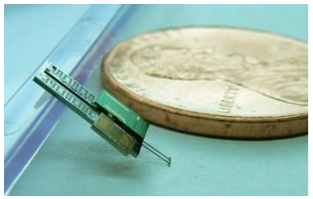


Results

- 110V unipolar drive voltage
- 1kHz drive frequency
- Miniature size (63mg)
- High efficiency (Max. 73.6%)
- High power density (Max. 7.9 kW/kg)

DoD Relevance

- Humanitarian Assistance and Disaster Relief
- Intelligence and Surveillance
- Planetary Exploration
- Building Mounds
- Highly Localized Drug Delivery
- Screening for Diseases



Collaboration between University of Maryland Micro Robotic Lab. http://terpconnect.umd.edu/~sarahb/ and the Power Electronics Group (www.ece.umd.edu/~khaligh)

Electromagnetic Biomechanical Energy Harvesting

Alireza Khaligh and Yichao Tang, Institute for Systems Research, Department of Electrical and Computer Engineering
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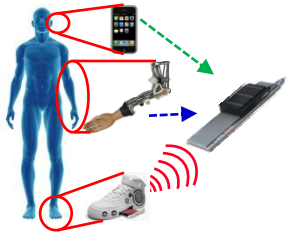
Research Objectives

Harvest Human Power in order to:

a) Provide backup power source
b) Enable power supply with no environmental constraint
c) Reduce logistics of carrying energy sources
d) Mitigate musculoskeletal injuries and metabolic cost in the case of a larger system

Enable Energy Harvesting through:

a) Developing a unique Permanent Magnet (PM) device optimized for human low-frequency
b) Investigating a unique integrated highly efficient Power Electronic Interface (PEI) to achieve power management



Technical Approach

PM Linear Generator

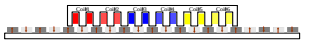
- Magnetic flux optimization
- Cogging force reduction
- End effect minimization
- Optimal sizing
- High power density

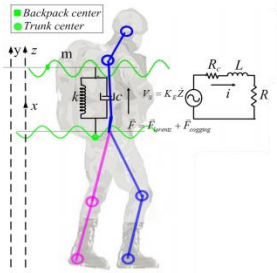
PEI & Energy Management

- AC/DC buck & boost
- Maximum power tracking
- Walking condition optimization
- High efficiency
- High power density

System Modeling

- Biomechanical model
- Electromagnetic model
- Electric circuit model
- Overall system model





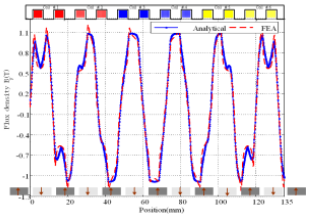
Significant Results

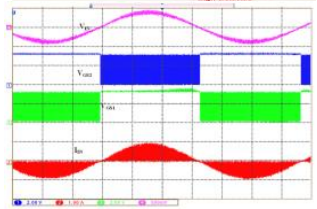
PM Energy Harvester

- Accurate mathematic system modeling
- Magnetic field optimization
- Detent force minimization

PEI Prototype & Results

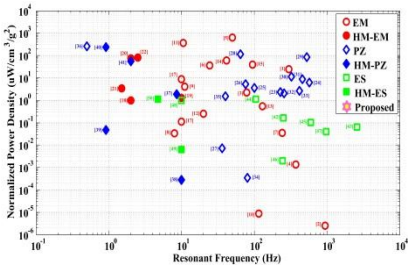
- Applicable to a small system
- Capability to handle low input voltage (0.4V)
- Miniature size (3.34g)
- High efficiency (Max. 71%)





DoD Relevance

- Energy and Self-Sufficient Operations
- Warrior Web
- Advanced Power Electronics
- Robust Portable Power Sources
- Precision Electronic Warfare
- High-Performance Mesoscale Actuators



Thermal Management: a Key Requirement in Present and Future Defense Platforms

Gary Mandrusiak and Yogen Utturkar, GE Global Research (gary.mandrusiak@ge.com)

Research Objective

- Develop portfolio of thermal management solutions leading to disruptive improvement in reliability and performance of military electronics

Research Importance

- Overheating responsible for > 50% of electronic component failures
- High-energy components de-rated to avoid exceeding thermal limits
- Existing thermal solutions often hurt SWaP

Technical Approach

- Extend fundamental heat transfer science to electronics thermal problems
  - Microchannels to remove heat from the transistor gate inside the die
  - Wicking structures to enable high-g performance of planar heat pipes
  - Integrated minichannels to supply liquid cooling directly to the backside of computer chips
  - Innovative materials and manufacturing processes to reduce thermal interface resistance
  - Compact air jets to augment local heat transfer

Significant Results

- Low-profile synthetic jets enhance local heat transfer rates at low power cost
- Microchannel-in-die concept manages transistor gate heat fluxes in excess of 5 kW/mm^2
- Copper nanosprings support ultra-thin thermal interface material with resistance < $0.01 cm^2K/W$ and no CTE matching restrictions
- Planar heat pipe provides effective thermal conductivity of 20 kW/mK at up to 20g

DoD Relevance

- Technologies motivated by thermal limitations in military electronic hardware
  - GaN on SiC power amplifiers
  - UAS hardware
  - Military computers
- Solutions verified to military standards
  - Hot and harsh environments
- Research sponsored by DARPA and GE business units

All Fuel Portable Power – High Efficiency External Combustion Technology

Christopher Nelson, President – Cyclone Power Technologies, Inc. (chris@cyclonepower.com)

Research Objectives

Problem:

Need for compact, efficient power converter to utilize multitude of new fossil and bio fuels, as well as waste resources

Importance:

Diversification of energy resources leads to:

Enhanced energy independence,

Reduced operating costs,

Environmental sustainability

Technical Approach

Advance clean "fuel agnostic" EC technology

Overcome major efficiency losses and design flaws with reciprocating EC engines:

- Integrate engine, combustion chamber and condenser in one package
- Eliminate motor oil from lubrication
- Recover lost heat from multiple processes
- Utilize latest materials

Significant Results

Operating temps to 1200°F; pressures to 3200 psi

33+% efficiency; path to exceed 50%

Run engines on multiple fuels without modification; integrated systems to run on waste fuels & biomass

Built several prototype engines from 5HP to 100HP

DoD Relevance

(1) Reduce fuel supply costs and logistical burdens
- Promote energy independence

(2) Enhance capabilities of troops
- Longer missions / lighter loads
- Use of locally-sourced fuels
- Disposal of camp waste

Use for portable/mobile power, transportation, robotics

The Creative Destruction of Defense S&T Program

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Research Objective(s)

- Federal FY 2012 R&D Budget was $125 Billion. DoD RDT&E consumed 60% of the Budget
- Innovation Gap : (a) insignificant DoD R&D into Service Innovation though DoD consumes more Service(s) than Product(s) , (b) Emerging Innovation notion also include innovations into Process and Execution sciences, and (c) Need to mitigate the DoD identified S&T challenges
- Objective: Develop an Innovation Management Model and related methodologies to mitigate the Gap.

Technical Approach

- Identified major components of Innovation
- Researched Academic and Corporate Innovation Management practices
- Developed an Innovation Management Model and a CMMI™-based maturity analysis
- Developed the concept of Critical Research Elements (CREs)

Significant Results

- An Innovation Management Model
- A Process to link the S&T program to the PoR using the Critical Research Elements (CREs) concept
- A process for Innovation Analytics

DoD Relevance

- The Innovation Management model may be used as a “straw man” to evolve the DoD S&T Program to “Innovation Program”.
- The CRE concept may be used to link the outcomes of the S&T Program to the PoR
- The Innovation Analytics process may be used to provide quantitative measure of the maturity of R&D projects.

EW Systems – Future Research in an Austere Budget Environment

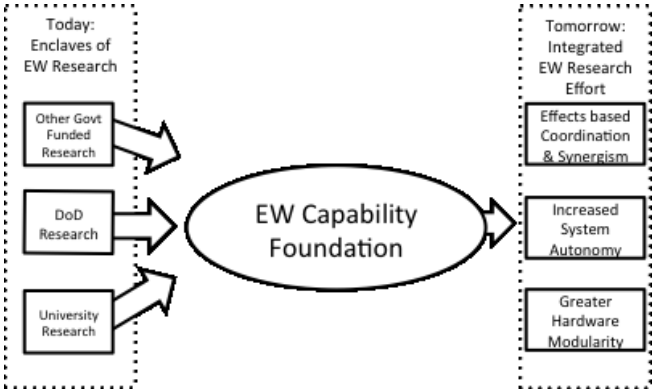
Vikram Sardana, Lockheed Martin Advanced Technology Laboratories (vikram.sardana@lmco.com)

Research Objective(s)

- Given future constrained DoD research budgets coupled with evolving EW & EMS space, how best to get the most "bang for the research dollar" within DoD?
- Future EW systems will need to be designed today with tomorrow's challenges in mind…there won't be a do-over…

Technical Approach

Pool research into a *Capability Foundation* enabling re-use and synergy between research labs within DoD.



Significant Results

- From the Capability Foundation, create cross-service strategic thrusts to address battlefield needs
- Three possible thrusts needed to prevail in future conflict:
  - Coordination – synergism on the battlefield with spectrum stakeholders
  - Autonomy – in light of reduced personnel footprint
  - Modularity – to shrink supply chain / reduce cost

DoD Relevance

- Pooling resources will hopefully mitigate loss off revenue
- Enable synergism between parallel research efforts
- Enable future capability in distributed, net-centric operations
- Facilitate simultaneous manned-unmanned operations
- Reduce cost of hardware and systems through re-useable, common building blocks

A Knowledge-Dominance Strategy for Sustaining DoD Technological Advantage

David A. Scott, Ph.D., J.D., Comm IT Enterprises, Inc. (david.scott@commitent.com)

Research Objective(s)

What problem are you trying to solve?

- Ensure capability for global innovation challenge of having to "*be smarter and run faster*"

Why is this project important?

- Agility requires better situational awareness and core processes that accelerate the OODA loop cycle
- China has a 30-year head start on the USA

Technical Approach

- ✓ Open-source literature review
- ✓ Benchmarking
- ✓ Case studies including successful models and lessons learned by key U.S. allies
- ✓ Taxonomic and bibliometric analysis
- ✓ Focus on megatrends changing the way innovation occurs today

Significant Results

Framework and strategy for:

- Paradigm shift for increasing innovation rates and disrupting advantages of others
- Effectiveness in unfamiliar asynchronous and asymmetric environments
- Enabling game-changing competencies

DoD Relevance

- **Tech investment approach** - McNamara-era "picking winners" approaches to investment, innovation, and technology security are no longer effective in the cyber universe
- Effective use of information technologies and techniques and re-purposed legacy tools requires a new DoD knowledge strategy/plan

Social Interaction Analysis at a Distance

Peter Tu, General Electric (tu@ge.com)

Research Objective

- Develop computer vision methods that can automatically infer the emotional state and intent of individuals and groups

Research Importance

- Need for improved situational awareness & threat assessment
- Need to improve detection/treatment of medical conditions

Technical Approach

Computer Vision

Significant Results

- Captures emotional cues to provide actionable information for warfighters
  - Group dynamics
  - Facial expressions & gaze directions
  - Body language & related psychological cues
- Automatically performs emotional inference/interpretation based on observed social cues

DoD Relevance

- Automated detection of suspicious behavior & team dynamics
- Cross-cultural communication training on recognizing social cues
- Detection and treatment of conditions such as depression, TBI and PTSD

CAIN: Wideband Anti-Jamming for GPS

Rick Vosburgh, Physical Devices LLC, Durham NC (rick@physcaldevices.com)

Research Objective:

1. Defeat of Extreme Jamming
   - Signal Agnostic
   - Intrinsically Stable
   - Low Computation
   - Low SWAP-C

Importance

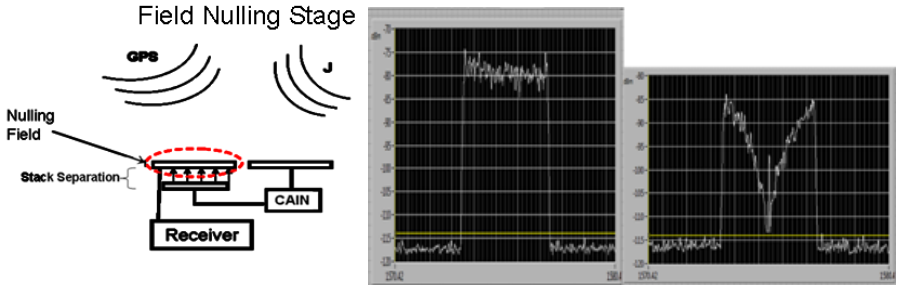
CAIN Will Protect GPS/COMMS Against Intentional & Inadvertent Interference

Technical Approach

Applying Physics of Optical Filters to RF

- UWB Tunable Feed-Forward RF Filters
  - Field Nulling to Block Jamming
  - Signal Nulling to Cancel Residual
- Purposeful Dispersion
- Signal Agnostic Operation
- Deterministic Cancellation
- Linear Phase BP Filters for GPS

Significant Results



COTS Patches; λ/4 Separation;
40 dB Mitigation

2nd Stage – Additive Performance

DoD Relevance

1. SATNAV & C3 for Tier 1 UAV
2. GPS for Dismounted Personnel
3. UAV Video Feed Reception
4. RF Network Synchronization
5. Iridium COM-NAV

Autonomy in Austere Environments: Unmanned Ground Vehicles as Force Multipliers

Noah Zych, Oshkosh Corporation (Email: nzych@oshkoshcorp.com)

Research Objective(s)

- Equal the reliability and mobility over complex terrain of a human-operated vehicle with an unmanned vehicle
- Enable an operator to command and control multiple UGVs from a single interface

Technical Approach

- Modernize existing-fleet tactical wheeled vehicles with autonomous capability

Significant Results

- Warfighter experiment integrating UGVs into a manned logistics convoy
  - Day/night, all-weather ops @ up to 35 mph on secondary roads + extended GPS denial
- 3-day training: novice → expert user

DoD Relevance

- Reduce vulnerability and enhance efficiency of sustainment forces along contested GLOCs