Visibility Improvement in Full Motion Video under Obscurants and Challenging Illumination

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Research Objective(s)

- Improve visibility and interpretability of ISR data from EO and IR sensors when data is compromised by illumination and environmental problems.
- Shadows, highlights, low light, fog, dust, pollution, and smoke in EO, and extreme heat variations in IR can mask important information, i. e., the presence or nature of threat, therefore endangering soldiers lives.

Technical Approach

- Real-time, fully unattended video enhancement
- Adaptive color correction
- Adaptive contrast enhancement
- Adaptive high dynamic range improvement
- Adaptive sharpness and noise reduction
- Sensor-in-the-loop unattended FMV mode
- Man-in-the-loop and forensic mode
- Applicable to entire spectrum - videos and stills
- Portable on Windows, Linux, and Android OS

Significant Results

EO Color

DOD Relevance

- Intelligence, Surveillance, and Reconnaissance
- Aerial, Maritime, Ground, and Space Sensing
- Manned and Unmanned Aerial Systems
- Unmanned Ground Vehicles
- Manned and unmanned Surface Vehicles
- Border and Perimeter Surveillance
- IMINT and GEOINT

Helping you see the unseen in motion and still imagery

Revelatum™ - Emergence Visualization

Lawrence An, President DAn Solutions (larry@dansolutions.com)

Research Objective(s)

What problem are you trying to solve?

- Revelatum™ reveals and visualizes complex knowledge and events within imagery, sensors and various data sources.

Why is this project important?

- Capture more knowledge from existing data
- Extend sensor platform capabilities
- Better leverage expanding open-source data

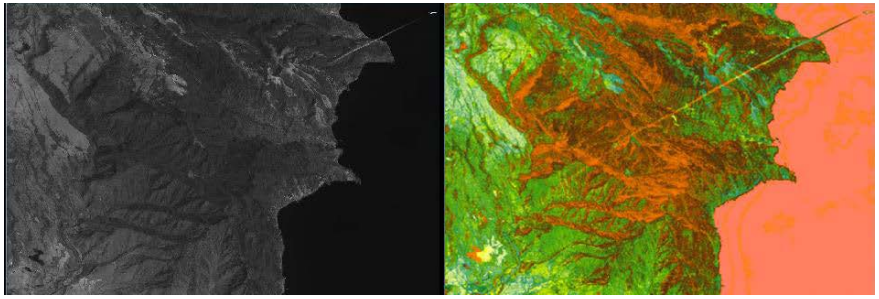
Technical Approach

Emergence as a science is patterns arising out of simple interactions / relationships. Revelatum™'s 150+ emergence processes rapidly:

- present unknown unknowns,
- reveal unknown information about the known,
- discover patterns, relationships, features & events,
- accelerate understanding through visualizations,
- enhance data accuracy & decision making,
- aid anticipatory intelligence.

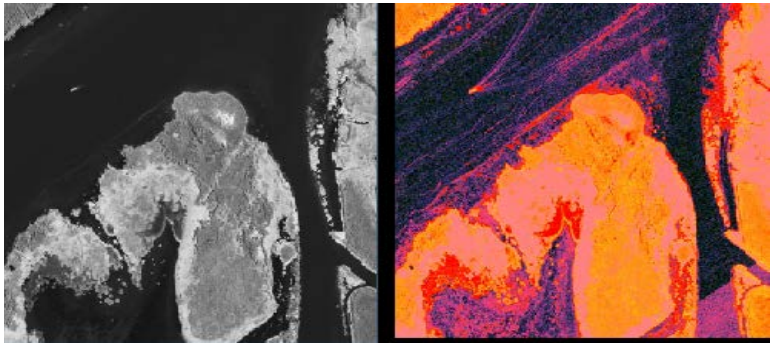
Significant Results

Missile Launch - Revelatum™ discovers and visualizes (right) a rocket tail signature across the image that is 3 times longer than the visual signature within the original optical image (left).



DoD Relevance

Detect – rockets, vehicles, roads, runways, infrastructure, camouflage, boats, wakes, shoreline, underwater shoals, vegetation, land faults, rivers, streams, anticipatory events (financial, social, cyber) and artifact.



R&D via Networks and Crowds

David Becker, National Defense University (David.Becker@ndu.edu)

Research Objectives

- Can networks of non-traditional collaborators develop or improve new technology for DOD?
- Can we crowdsource solutions via global networks?
- Discover ready-to-use private sector solutions from non-DOD contractors?
- Speed development and deployment?

Technical Approach

- Built Star-TIDES global network of distributed talent from non traditional partners focused on assisting local populations and willing to collaborate on DOD projects
- Supported challenges, field experimentation and testing of available solutions with DoD participation
- Focused on low-cost technology that can be quickly and easily fielded by DoD and US Government counterparts.

Significant Results

- Joint NDU-NPS-DoD interagency field experiments that resulted in the integration of new technology and operations into FEMA, DHS and State Department disaster response and humanitarian aid actions.
- Challenges via network provided new solutions for water filters, mine and IED reporting, disaster flood reporting.
- Discovered or developed technology that can be sustained by our partner nations, rather than operated by costly DOD contractors.

DoD Relevance

- Using “radical inclusion” to involve non-traditional partners (NGOs, entrepreneurs, UN and others) has provided new approaches and technologies that have assisted in DOD R&D
- Low-cost technologies save money and time
- Supports building partner capacity
- Such crowdsourcing technologies and approaches can be quickly incorporated across DoD and inter, intra-agency and whole-of-government approaches.

ACES: Better collaboration through spatial computing

Matthew Burton, Hadron Industries (Email: matthew.burton@hadronindustries.com)

Research Objective(s)

Develop spatial computing applications that ease information overload.

Technical Approach

ACES replicates and distributes pixels across every screen in a work environment. This gives team members real-time awareness while lowering bandwidth requirements and integration complications.

Significant Results

A mature prototype has been deployed to AFRL, Army Geospatial Center, and more. Developing CONOPS, TTPs, and other processes to evaluate the system in an operational environment.

DoD Relevance

Information overload demands new tools to maintain situational awareness and foster analytic collaboration. ACES' platform- and network-agnostic framework is well-suited for DoD's diverse enterprise of legacy systems and disparate networks.

Maximizing ROI through Multi-Modal Behavioral Stimulation & Panel Research

Charles Dahan

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Research Objective(s)

- Create panel for longitudinal research to predict ROI for campaigns in volatile regions, with near-real time experimental implementation
- Framing & priming effects & strategies related to acquisition & deployment campaigns
- Creation of new method for testing opinion: multimodal conjoint analysis utilizing DoD-grade security infrastructure
- Proof of concept through domestic pilot study

Technical Approach

1) Creation of representative human behavioral panels in volatile regions
2) Deployment of framing, priming, & social psychological behavioral experiments.
3) Multi-modal (online, SMS, in-person) survey methods prior to, during, & following resource acquisition, deployment, & intervention

Significant Results

- First tangible method for creating & "working" survey panels in volatile regions utilizing mixed method surveys for public-sector use, ***with integration with cloud-based data sources maintaining DoD-grade security.***
- Successful pilot test with domestic sample, testing messaging, framing, & priming regarding support for acquisition, budgeting, & intervention

DoD Relevance

- Improvement upon public opinion methods currently utilized, increasing ease of use, cost effectiveness, & ROI.
- Method for predicting implications of acquisition & deployment
- Behavioral panels for longitudinal research offer real-time, flexible methods for predicting outcomes & reducing intervention risk.

Keeping Battlefield Windows Clear & Stealthy

George Dubé MetaStable Instruments gdube@metastableinstruments.com

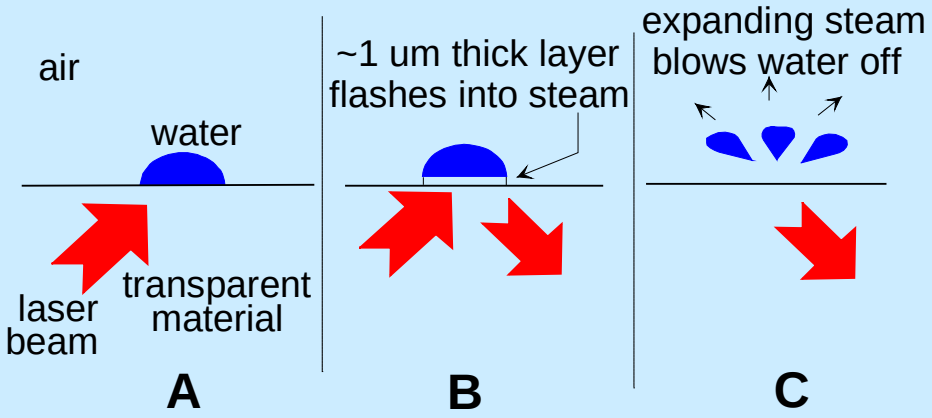
Research Objective(s)

Keeping battlefield windows clear and stealthy

- "Hot window" defroster problems
- Laser weapons & optical sensors
  need clear windows on windy snowy or rainy days

Technical Approach

Explosive blow-off via attenuated TIR



Significant Results

Mud & water removed from AlON® window by a single 5 mm diameter laser beam **within** the window

DoD Relevance

More & bigger windows are heading into hostile environments

Glasses-Free 3D Volumetric Display for Enhanced Decision-Making

Doug Freitag, 3DIcon Corp. (Email: dfreitag@3DIcon.net)

Research Objective(s)

- Increase the ability to leverage unprecedented amounts of 3D information through advances in visualization.
- Current approaches to displaying 3D data limits the users' ability in create actionable insights that are reliable, accurate, and timely.
- 3DIcon overcomes these limitations with a glasses-free 3D volumetric display (CSpace®)

Technical Approach

- Data is visualized in a static cube of specialty glass
- Specialty glass contains rare earth metals that emit visible light when illuminated simultaneously by two IR lasers
- The uniqueness of CSpace® is that the lasers illuminate the transparent media sequentially with 2D slices of data that at high video rates create a 3D image made of volumetric pixels "Voxels".
- Advantages include higher resolution, larger images, animation, less computer intensive, no limitation in viewing angle or depth and visualization of actual internal features

Significant Results

- Laboratory prototype complete
- Components shown to work together
- Monochrome image visible in ambient lighting
- 64 cm^3 image chamber
- 1024 x 768 projection x 30 slice scanning resolution = ~ 23 million voxels
- Future: 800 million voxels, full color, desktop format.

DoD Relevance

- Cyber data visualization
- Healthcare (telemedicine/training/diagnostics/surgical planning/telemedicine/biosurveillance)
- Mission Planning/Training/threat assessment
- Battlespace situational awareness
- Autonomous piloting
- Meteorological and Oceanographic data visualization
- Security screening

Data Analytics impact on Science and Engineering

Dr. Tommy Gardner, PE, Scitor Corporation (tgardner@scitor.com)

Investigate how the Big Data analytical toolkit will change the way we perform science and engineering.

What do Scientist and Engineers need to understand to be effective in the new information age?

There is a potential for exponential improvement in cost and performance of systems

Review the current tools used at Facebook, Google, YouTube, Pinetrest and SnapChat for applicability.

Understand the real time statistical analysis that can be conducted to monitor physical systems.

Explore what expert systems like IBM Watson can do to the speed accuracy and cost in design.

Innovation occurs at the conjuncture of two fields. Data analytics will be embraced by engineers in such ways as finite element analysis (FEA), Computational Fluid Dynamics (CFD) and dynamic stress and strain calculations.

DOD benefits from faster, less costly systems designs.

Systems that have run optimization software on all possible variables and determined point for best solution.

Predictive analytics on weapons systems for optimal performance and availability.

Communications-Enabled Coordinated Sensing

Michael Luddy, Lockheed Martin MST (michael.j.luddy@lmco.com)

Research Objective(s)

Address the challenges of raids, low RCS, jammer proliferation, C-SWAP challenges.

In this presentation, we show how this future threat/challenge can be defeated by integrating low-cost platforms with large platforms using multi-platform multi-sensor (MPMS) techniques.

Technical Approach

Enhancement of multiple sensors with adaptive multiplatform coordination of dwells, with optimization of sensors and communications with a mixture of centralized and decentralized processing

Cognitive/ad hoc networking increase low probability of intercept/detection (LPD/LPI) thus providing substantial advantages in challenged/contested environments

Significant Results

MIMO radar gains

Spectrum sharing

Passive sensing techniques

The use of undeniable natural phenomena provides protection against jamming.

DoD Relevance

CECS allows for joint use, coordination, and adaptation of all sensors on all platforms for improvements against a wide variety of threats—facilitating improvements in all stages of operation including the kill chain.

AF Technology Interchange Model

Used to Facilitate IR&D Dialogue between DoD & Industry

Giovanni Pagan, AF IR&D PM, AFRL, giovanni.pagan@us.af.mil

Initiative Objective(s)

- *Provide structure to DoD & Industry Technology Interchanges*
- *Structured Model critical to Enhancing Awareness*
  - *Inform Industry of Warfighting Capabilities & Gaps Requiring Attention*
  - *Inform DoD of Significant Technology Innovation in IR&D Portfolios*

Technical Approach

- *Apply proven AF Model for COI-level IR&D engagements with Industry*
- *Enable Flexibility to COI Steering Groups in specifying content*

Significant Results

- *Prototype application with Human Systems COI in 2013*
  - *Resulted in several CRADAs generated*
  - *Enabled Academia & Small & Mid-sized Companies to Engage*
  - *Estimated savings of over $250K in travel & labor of average of 30 technical SMEs to visit disparate locations*

DoD Relevance

- *Central to BBP 3.0 Tenets*
  - *Incentivize Innovation in Industry & Government*
  - *Increase the Productivity of Industry IR&D and Contracted R&D*
- *Persistent and Disciplined DoD Ties to Defense Industrial Base*

Multi-Function, Affordable, Small Transceivers (MFAST)

Doug Robl, Lockheed Martin MST (Douglas.Robl@lmco.com)

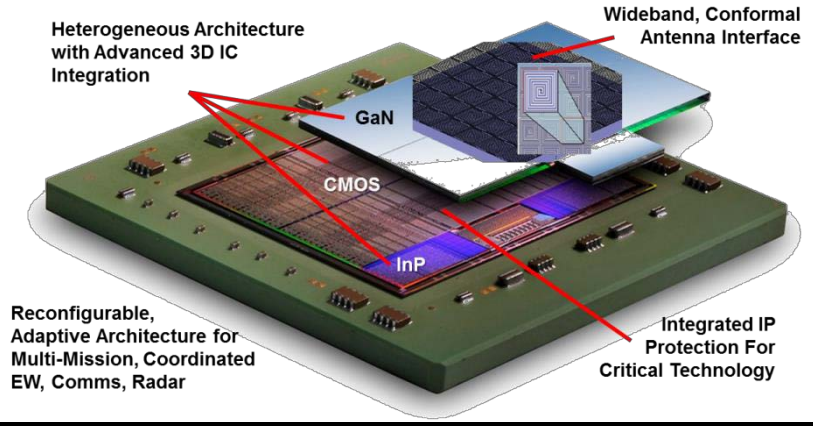
Research Objective(s)

- Current Electronics Design Landscape presents unique challenges to DoD system developers:
  - Advanced node design costs increasing exponentially
  - Advanced semiconductor technology is global
  - Effective C4ISR requires unfettered use of an increasingly congested EM spectrum
- A common, scalable transceiver building block reduces development time, cost, while bringing economies of scale to DoD weapon systems
- MFASTs provide solutions for distributed, coordinated operations by integrating promising emerging technologies

Technical Approach (Guiding Principles)

Heterogeneous Integration | Innovative Architectures | Reconfigurability

Multi-Function, Affordable, Small Transciever (MFAST) Concept Illustration



Significant Results

- Examples Lockheed Martin Developments (to date) Include:
  - S-Band to Bits SoC Receiver in SiGe BiCMOS
  - High-Linearity, Multi-Tone Transmitters from DARPA PowerDAC
  - Reconfigurable Transceiver Building Blocks from DARPA Arrays at Commercial Timescales (ACT)
  - Advanced Thermal Management with DARPA ICECool

DoD Relevance (OV-1)

Transition from Large, Expensive Systems to Smaller, Coordinated Assets Requires Capable Transceiver Electronics on Smaller Platforms