

AEROSPACE & DEFENSE™

TECHNOLOGY

The Engineer's Guide to Design & Manufacturing Advances

Welcome to your Digital Edition of *Aerospace & Defense Technology* May 2016



How to Navigate the Magazine:

At the bottom of each page, you will see a navigation bar with the following buttons:



Arrows: Click on the right or left facing arrow to turn the page forward or backward.



Introduction: Click on this icon to quickly turn to this page.



Cover: Click on this icon to quickly turn to the front cover.



Table of Contents: Click on this icon to quickly turn to the table of contents.



Zoom In: Click on this magnifying glass icon to zoom in on the page.



Zoom Out: Click on this magnifying glass icon to zoom out on the page.



Find: Click on this icon to search the document.

You can also use the standard Acrobat Reader tools to navigate through each magazine.



Stocking Distributor
UAVs Sensors Software Support
Complete Inspection Solutions



gapwireless.com/UAV

closing
the
gap

Free Info at <http://info.hotims.com/61061-839>



Cov

ToC

AEROSPACE & DEFENSETM

TECHNOLOGY

The Engineer's Guide to Design & Manufacturing Advances



**Bi-manual Dexterous Manipulation
for Maritime Explosive
Ordnance Disposal**

**Designing Rugged Computing
Platforms for UGVs**

**Designing a Robot to Counter
Vehicle-Borne Improvised
Explosive Devices**

SPECIAL ISSUE
**Unmanned Vehicle &
Robotics Technology**

From the Publishers of  **TECH BRIEFS**

PHOTOFABRICATION ENGINEERING, INC.

www.photofabrication.com



CHEMICALLY
MACHINED
AEROSPACE &
DEFENSE SYSTEM PARTS

Visit us at the:



International Microwave Symposium IMS 2016
22-27 May 2016 San Francisco, California, Booth 110



UNCOMPROMISED QUALITY



MILFORD, MA. USA

Free Info at <http://info.hotims.com/61061-701>

We are on our way to a much higher standard of manufacturing!

Imagineering is in the process of receiving

**AS9100
Certification**

from ANAB Accredited Agency

The AS9100 is a technical specification aiming to the development of a quality management system for the Aerospace industry. It provides for continued improvement, emphasizing defect prevention and the reduction of variation and waste. AS9100 fully incorporates the ISO 9001 standard.

For last 30 years we have been focused on delivering Leading-Edge Technology. Imagineering has been following the highest standards of manufacturing and workmanship in Fabrication & Assembly of Printed Circuit Boards

ITAR Registered ISO Certified UL Approved
WEEE Approved CCR Registered ORCA Registered



imagineering inc

Certified Woman Business Enterprise (WBE)
Certified Woman-Owned Small Business (WOSB)
Certification# RWOSB14859 & RWBE14858 (13 C.F.R Part 127)

Free Info at <http://info.hotims.com/61061-702>



Imagineering
Winner of
Family Entrepreneurship
QUINLAN
SCHOOL of ENTREPRENEURSHIP



Contents

FEATURES

6 UAV Technology

- 6 Using SWaP-C Reductions to Improve UAS/UGV Mission Capabilities

10 UGV Technology

- 10 Designing Rugged Computing Platforms for UGVs

16 UUV & Robotics Technology

- 16 Bi-manual Dexterous Manipulation for Maritime Explosive Ordnance Disposal

22 UUV Technology

- 22 Applying UUV Advances to Safeguard Harbors and Littoral Waters

26 Robotics Technology

- 26 Designing a Robot to Counter Vehicle-Borne Improvised Explosive Devices

32 Tech Briefs

- 32 Autonomous Underwater Munitions and Explosives of Concern Detection System
33 Power-Line UAV Modeling and Simulation
35 Design of a Multi-Segmented Magnetic Robot for Hull Inspection

- 38 A Modular Approach to Video Designation of Manipulation Targets for Mobile Manipulators
39 Two-Dimensional Distributed Velocity Collision Avoidance
40 Undersea Communications Between Submarines and Unmanned Undersea Vehicles in a Command and Control Denied Environment

DEPARTMENTS

- 43 Application Briefs
48 New Products
52 Advertisers Index

ON THE COVER

An artist's rendering depicts RE2 Robotics' concept of an electromechanical underwater manipulator designed to carry out hazardous submerged explosive ordnance disposal (EOD) missions. To learn more, read the feature article on page 16.

(Image courtesy of RE2 Robotics)



**KATHLEEN
FASENFEST**
High-performance
antenna systems

A LOW PROFILE HAS ITS ADVANTAGES

Antennas play a critical role in aerospace from communication to navigation to wireless entertainment. And while amazing performance is important, when it comes to antennas, bigger doesn't always mean better. Reducing the size and lowering the profile of aircraft antennas requires powerful ideas, and that's where our engineers are superstars. TE Connectivity (TE) is helping to shrink the size of airline antennas to reduce the risk of injury to ground crews and dramatically improve aerodynamic performance and fuel economy.

Get connected to the inner circle of TE AD&M's best thinkers at DesignSmarterFaster.com. Working together early in your design review process, we can help you reach a better connectivity solution.

©2016 TE Connectivity Ltd. family of companies. All Rights Reserved. EVERY CONNECTION COUNTS, TE Connectivity and TE connectivity (logo) are trademarks of the TE Connectivity Ltd. family of companies. Other logos, product and/or Company names might be trademarks of their respective owners.

EVERY CONNECTION COUNTS





Proven Performance



GORE-FLIGHT™ Microwave Assemblies, 6 Series are ruggedized, lightweight and vapor-sealed airframe assemblies that withstand the challenges of aerospace.

With GORE-FLIGHT™ Microwave Assemblies, 6 Series, a fit-and-forget philosophy is now a reality – providing the most cost-effective solution that ensures mission-critical system performance for military and civil aircraft operators.

Find out why at:
www.gore.com/GORE-FLIGHT



Visit us at IMS 2016, Booth 1547



precision

lightweight

durability

GORE, GORE-FLIGHT, the purple cable and designs are trademarks of W. L. Gore & Associates.

Follow us on



Free Info at <http://info.hotims.com/61061-704>



Cov

ToC

INSIDE STORY

When used in unmanned vehicles and robots, wires and cables must meet exacting standards developed to ensure that the finished products will always perform as intended, in incredibly harsh environments, with infinitesimal failure rates. To learn about the capabilities needed to satisfy such demands, *Aerospace & Defense Technology* recently spoke with Joshua Spaulding, a design and project engineer at New England Wire Technologies (NEWT), Lisbon, NH, an industry supplier with decades of experience developing custom wire and cable assemblies for unmanned vehicles and robots.



A&DT: You're a project engineer specializing in cables for robotics and unmanned vehicles. What's the relationship between those two applications?

Joshua Spaulding: We do a lot of robotics designs and one group of applications is for unmanned vehicles such as drones, robotic vehicles, and aerospace vehicles. They go hand-in-hand. Our applications generally require high strength and durability because robotics experience continuous flexing and continuous movement.

A&DT: Does minimizing size and weight affect the flexibility?

Spaulding: In some cases, it can. Depending on the application, we can choose an alloy material and increased stranding. Increased stranding helps us extend flex life. As we add more strands, the load becomes more distributed so it doesn't break down after continuous flexing as easily as it would with fewer ends.

A&DT: What are track and torsion flexing?

Spaulding: Track flexing is longitudinal – laying a cable flat and then pulling it back, creating a bend radius. Torsion flexing is when you twist the cable.

A&DT: How do you test flex life?

Spaulding: We have in-house custom testing equipment that can measure the flex life of the cable. Included is a standard bending endurance (track-flexing) tester where the cables are attached to a fixture and rotate about a mandrel. We also have a torsion tester, which is a rotating arm that twists the cable back and forth 360 degrees.

A&DT: What makes the signal quality go down?

Spaulding: It's usually the motion of the components inside the cable that causes that. As it flexes back and forth, the individual conductors inside the insulation stretch out. That draws the conductors down, increases the resistance, and degrades the signal.

A&DT: Do you have a way of measuring electrical performance?

Spaulding: Yes. We use specialty devices for measuring electrical performance. We also measure velocity of propagation, which is important in robotics applications, where you're trying to get the fastest signal time so it doesn't delay the response of the robotic device.

As an example, one of the things we are capable of is DVI testing, which is an analysis of the interference between cable

members (intra-pair skew), signal speed, and signal quality (attenuation).

For a quick reference we use a Signal Integrity Network Analyzer to generate eye diagrams for different frequencies. Eye diagrams give an indication of signal quality and jitter, which is caused by deviation in pulse amplitude and phase in high frequency digital signals.

A&DT: How about shielding?

Spaulding: Shielding is important. We offer different types. Braided shields are typically used in robotics applications because the abrasion resistance provides an extra layer of protection and a more consistent coverage over the flex life of the cable. Spiral shields are something else we offer, but what happens over time as they're flexed, the shielding wires will bunch up and you'll lose some of the effectiveness of the shield.

A&DT: Why do you use alloys for the conductors?

Spaulding: They have superior flex life compared to pure metals.

A&DT: What sorts of alloys do you use?

Spaulding: For robotics applications, we offer cadmium alternatives because cadmium has good properties: thermal stability and high tensile strength. Sometimes we'll offer a CA162 or 182, which are RoHS compliant versions that don't actually have cadmium in them, but they're similar in quality. High conductivity is also important so we do silver plating, which increases the conductivity. It also helps with chemical resistance and temperature performance. And it's solderable, which is really important in robotics, because you're making a lot of connections.

Another product we offer is tinsel wire, which is probably the best kind of conductor to use in a robotics application, because it uses an alloy material wrapped around a strength member. The downside to the tinsel wire is its increased resistance. It's also slightly larger and costs more.

A&DT: Do you ever have to deal with high temperature or chemical resistance specs?

Spaulding: We can design for that. We'll apply silver to the conductors for thermal and chemical stability. We'll also use the alloys, which have improved temperature properties.

We also offer Parylene coating. Parylene coating is inert and biocompatible, and provides a dry lubricant on the cable jacket that resists heat, radiation, and solvents, as well as fungal and bacterial growth.

To find out more about New England Wire Technologies, visit the full-length version of this interview available online at www.aerodefensetech.com/InsideStory0516.



NEW ENGLAND WIRE TECHNOLOGIES

Custom Designed Wire and Cable Solutions for the Aerospace and Defense Industries

Miniature or Microminiature Options

Multiconductor

Low Noise

Ultra-flexible

High Temperature

Reinforced Jackets

Coaxial Cables

Hybrid Configurations

Designed specifically to meet the unique performance
characteristics of your application.

www.newenglandwire.com
603.838.6624



Free Info at <http://info.hotims.com/61061-705>



Using SWaP-C Reductions to Improve UAS/UGV Mission Capabilities

(U.S. Army)

The defense and aerospace market continues to push for reductions in size, weight, power, and cost (SWaP-C) to support advanced sensor/vetronics payloads on-board unmanned platforms. Ground-breaking SWaP-C reduction for processor and network switch systems are enabling UAS (unmanned aircraft system) and UGV (unmanned ground vehicle) platforms to expand their mission capabilities. Several technologies are driving this small form factor revolution, including tightly integrated system-on-chips (SoCs), semiconductor packaging advancements (i.e. smaller nanometer dies, lower voltage chips), and micro-miniature rugged connectors.

The need for ever greater SWaP reductions stems largely from the balance between the small size of many unmanned platforms and the amount of payload electronics that needs to be integrated on those platforms. For the most part UGVs, UUVs, USVs, UAVs are smaller platforms, and generally speaking their mission and purpose is to serve as a sensor host for information gathering. These sensors can include FLIR cameras and other types of imaging

technology to conduct surveillance, and capture video or photos or mapping information.

The platforms might also include onboard sensors used to remotely control the aircraft or vehicle, or to allow autonomous operation of the platform. This requires that various processing elements and various sensors are interconnected to gather information. Typically, if there are multiple processors on the platform they will be supported with a data commu-

nications network, which is driving the need for smaller processor and network switch connectivity. At the same time, system designers want devices that meet the requirements, from an environmental and EMI standpoint, to operate in harsh environments such as at high altitude or during water ingress. Other notable reliability concerns that need to be mitigated include dealing with “dirty power” that might otherwise damage devices due to high voltage surges or spikes, and also noisy electrical environments aboard the vehicle that may disrupt adjacent devices.

Helping to increase requirements for SWaP reductions is the issue of how weight can affect a mission’s endurance. One UAS customer states that every pound they can eliminate from their combat UAS platform saves them approximately \$60,000 in cost for their vehicle. For an ISR (intelligence, surveillance and reconnaissance) mission platform, it’s calculated that it costs \$30,000 to add a pound, or inversely saves \$30,000 to eliminate a pound. So what are these costs? Where do they come from?



Parvus DuraCOR 310 Quad-core i.MX6 ARM miniature rugged mission computer.

WE'RE THE MANUFACTURER YOUR COMPETITION WANTS KEPT SECRET.

Companies large and small leverage our rapid manufacturing services when speed-to-market is critical and on-demand parts are needed beyond launch. We've been told it's their supply chain secret weapon. But you didn't hear it from us.

CUSTOM PROTOTYPES AND LOW-VOLUME PRODUCTION FOR THOSE WHO NEED PARTS **TOMORROW.**

proto labs®

Real Parts. Really Fast.™

3D PRINTING | CNC MACHINING | INJECTION MOLDING

ISO 9001: 2008 Certified | ITAR Registered | 2016 Proto Labs, Inc.



FREE BOOK

Request your
Digital Manufacturing
for Dummies book at
go.protolabs.com/DB6DJ.

Free Info at <http://info.hotims.com/61061-706>



Cov

ToC



One key contributor is fuel. There's a tradeoff analysis of how much capability a platform can provide given a specified weight for the electronics, fuel, and ammunition, etc. If one element is removed you can add more of another. But if you can shrink the physical size and weight of the payload electronics you can potentially get more functionality in the same physical space.

Switch Sizing

As an example, a couple of years ago, one of the largest US Army tactical UAS platforms had a requirement for network readiness, involving the integration of an onboard Gigabit Ethernet network. Given that the UAS was a smaller platform, the customer performed a volumetric analysis and determined that the size available for the network switch was roughly the size of a pack of playing cards, and ideally about half a pound in weight.

At the time, when the requirement arose, we had a COTS Ethernet switch that met the functional requirement but exceeded the allowable weight. We had already developed a roadmap for a miniaturized version of the switch and we accelerated the timing to accommodate this program. As a result, we designed, without NRE, a COTS solution that was half a pound in weight and just 10 cubic inches in size. This was 10% of the weight and size of our smallest previous GbE switch product.

What enabled us to miniaturize the GbE switch? Today, both processors and networking devices are evolving to include more functionality in their physical packaging. While previously the system



Ultra-small form-factor DuraNET 20-11 Ethernet switch supports network backbone upgrades on swap-constrained UAS platforms.



MQ-1C Gray Eagle in flight. (U.S. Army)

architecture might require multiple different devices, today we have access to system-on-a-chip alternatives that combine processing, memory, other controllers, interfaces, and physical transceivers all on a single chip. The system-on-chip has been a tremendous tool in the miniaturization of military electronics.

Beyond the miniaturization provided by the SoC, you need to consider the physical packaging of the system, including the metal, the connectors, and the thermal needs of the device. As manufacturers of these next generation SoC devices are reducing the thermal needs of the silicon, they are producing devices that are lower power and, therefore, the system requires less power dissipation in terms of the surface area of the system enclosure. Enclosures can now be smaller and still dissipate the heat that is generated by the device.

Connectors and Computers

The connectors that bring out all the I/O signals for the Ethernet and other computer I/O have also advanced in recent years. The traditional MIL-DTL-38999 connectors are still widely used and accepted. However, next generation micro-miniature versions of the connector are now available that provide the same or better physical, EMI, and electrical performance. These have

higher density contacts and the physical size and weight of the connectors are roughly half that of traditional options. Traditional 38999 shell sizes, together with MIL-STD-1472 Human Engineering recommendations for connector spacing, has driven the size of the connector panel and enclosure. With the new micro-miniature connectors, we are able to shrink the physical height of the box. In the case of our miniature GbE Ethernet system, the box is now barely over an inch tall.

Another example of a small form factor component suitable for unmanned vehicles is the recently introduced Parvus DuraCOR 310 tactical mission computer based on a low-power, four-core NXP i.MX6Quad ARM processor. This ultra-small system measures less than 40 cubic inches in volume, weighs less than 1.5 lbs and requires only 10 watts of power. It supports a high level of I/O flexibility through the use of dual PCIe-Mini Card I/O expansion slots. The mission computer features an industrial grade ARM-based Computer-on-Module (COM) tightly integrated with a Flash SSD and system carrier board, which provides a full complement of standard vetronics I/O interfaces including CANbus, USB, Ethernet, serial, DIO, video, and audio. The system's combination of small size, low-



UAV Technology

power multi-core processing, and flexible I/O represents the key design targets that system designers for unmanned systems are seeking to be able to add new Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities to their platforms.

What's more, these small mission computers need to be rugged to be able to perform optimally in the hard environments endured by unmanned platforms, whether the heat of desert tarmacs or the extreme cold of high altitudes. The use of the low-power ARM processor helps ensure that tiny mission computers can support a full range of military operating temperatures, from -40 to +71°C (-40 to +160°F) without fans or active cooling requirements. To ensure it's ability to perform under the extreme shock/vibration conditions, high altitude, and humidity, required by mobile, tactical, aerospace, and ground vehicle applications, the unit will be fully validated through qualification testing to extreme MIL-STD-810G, MIL-STD-461E, MIL-STD-1275D, MIL-STD-704F and RTCA/DO-160G test conditions for environmental, power and EMI (thermal, shock, vibration, dust, water, humidity, altitude, power spikes/surges, conducted/radiated emissions and susceptibility). Housed in a rugged sealed IP67-rated (dust and water proof) aluminum chassis with MIL-performance circular connectors, the DuraCOR 310 features advanced EMI filtering and power conditioning to protect against input vehicle/aircraft voltage surges, spikes and transients.

The breakthroughs in SWaP-C reduction resulting from continued increases in device density, packaging improvements and connector size miniaturization will help drive the development of smaller, more effective unmanned platforms. As these platforms expand their mission capabilities, our warfighters will benefit from better, more real-time intelligence.

This article was written by Mike Southwork, Product Marketing Manager, Curtiss-Wright Defense Solutions (Ashburn, VA). For more information, visit <http://info.hotims.com/61061-500>.

"WHAT'S IT GOING TO TAKE TO ACHIEVE THIS ID?"



**PRECISION.
RELIABILITY.
EXPERIENCE.**

We've got what it takes to support aerospace engineers.

When you need to specify shafts with unmatched concentricity and challenging ID work, in the most advanced alloys, talk to the world leader in custom tubular components.

We do it right the first time, every time.

CONTACT US:
1.207.892.8899
TUBEHOLLOWS.COM

 **TUBE HOLLOWS
INTERNATIONAL**
World leader in seamless precision

Free Info at <http://info.hotims.com/61061-707>

PERMANENT MAGNETS AND MAGNETIC ASSEMBLIES

UNBEATABLE QUALITY, SPEED AND PRECISION.



Since 1973, **MCE** has built its reputation on the principles of uncompromising quality and precision. With a state of the art manufacturing facility which is certified to SAE AS9100 Rev C and ISO 9001:2008, we produce quality magnets, magnetic assemblies and subassemblies with the shortest lead times in the industry.

Magnetic Component Engineering, Inc.

Tel 310.784.3100
www.mceproducts.com
mcesales@mceproducts.com
SAE AS9100C | ISO 9001:2008



Designing Rugged Computing Platforms for UGVs



(U.S. Army photo by Stephen Baack)

While the military's proliferation of unmanned aircraft, or drones, continues to grab the headlines, the deployment of unmanned ground vehicles (UGV) is also anticipated to expand based on their role in helping military operations become more agile, responsive and safe. Intensifying mission requirements for UGVs called for in Future Combat Systems (FCS) depends on their ability to cost-effectively contribute to significant increases in intelligence through reconnaissance, surveillance, and target acquisition, coupled with the ability to handle high-risk or labor intensive tasks and the efficient transporting of personnel and materials.

Initial UGV design progression was hampered because they were typically based on proprietary technologies due to quick deployment needs or service-specific requirements. Helping to propel UGV innovation is the availability of continuing advancements in open architecture COTS computing platforms. Now, UGV designs can more easily meet a long and growing list of interoperability, modularity and communications requirements and autonomous operation capabilities.

Suppliers of proven COTS platforms continue to broaden their portfolio with a range of solutions to satisfy strict size, weight and power (SWaP) mandates while featuring the latest multi-core

processors, technologies and intelligence capabilities. In addition, highly ruggedized platforms ensure land-based vehicles meet system reliability and maintainability goals with their ability to withstand harsh environmental conditions where shock and vibration, dust, weather, obstacles, terrain and even hostile electromagnetic and cyber environmental concerns are all constant issues. Hand-in-hand with harsh environments is the careful consideration of thermal load and system efficiencies to maximize battery life that result in the utmost operational availability.

Leap-Ahead Computing

UGVs have been used in thousands of counter-IED missions, which made them indispensable in Iraq and Afghanistan. While they have proven their worth in saving lives, the Department of Defense (DoD) has also directed that next-generation UGV solutions continue to progress and at the same time be 'affordable and cost-effective' in a time of decreasing budgets. Understanding the severe operating conditions UGVs encounter, the DoD has specified that these systems must meet or exceed identified reliability goals to ensure they can accomplish their missions once they've been deployed. Interoperability, too, is integral to the continued success of UGV missions.

Contributing to many of the aspects

called out in the RS JPO UGS (Unmanned Ground Systems) Roadmap (<http://archive.defense.gov/pubs/DOD-USRM-2013.pdf>), advanced COTS-based technologies inherently reduce lifecycle costs across all systems due to their interoperability and modularity, improved communications capabilities and the ability to support complex integration of such systems as weapons payloads. In order for UGVs to provide the "leap ahead" payload, communications, sensor or imaging capabilities expected, computing platforms must be based on the latest multi-core processors. Available in a variety of form factors and based on existing MIL standards, today's COTS solutions support the need for a common UGV architecture.

For example, the operational value of a UGV increases significantly if it can offer increased sensor capabilities or intelligent payloads combined with the ability to change or update any of these based on specific mission profiles. This highlights the value from modular plug-and-play payload capabilities that enable expanded UGV combat roles. Modular platforms enable the DoD to easily implement functionality and material improvements to deployed systems.

For UGV upgrades, built-in tests are not sufficient when a system becomes degraded or outdated. Modular systems make maintaining and replacing systems streamlined, especially in harsh



*Providing Lightweight Solutions...
...When Situations are Heavy.*

PTI Engineered Plastics recognizes the challenges that our military faces — extreme temperatures, rugged terrain and other hidden dangers. At PTI, we build products that are lighter, stronger and more adaptable; specializing in complex, low volume plastic injection molding. We can design, engineer and manufacture any part to your specifications and deliver it in just days.

To learn more, call 586.263.5100 or visit teampti.com



Prototype | Design | Engineering | 3D CAD Modeling | Tooling | Molding | Manufacturing | Cleanroom Molding

Free Info at <http://info.hotims.com/61061-709>



Optimized for high shock- and vibration-proof mobile applications such as UGVs, the Kontron COMe-cBTi6R offers an extended temperature range of -40°C to +85°C. Integrating Intel® Atom™ E3800 family processors and soldered RAM, it can deliver up to 4GB LPDDR3 with ECC or up to 8GB LPDDR3 without ECC. For safety-critical operation, it supports the Rapid Shutdown feature, an extremely fast shutdown that minimizes the risk of system or data tampering.

battlefield environments where there are few infrastructure support resources. According to the most current UAS report to Congress, UGV systems must be 'simple and supportable by the operators and maintainers in the field' to maximize their usability and viability.

Persistent support of 24 hours or longer is an ongoing requirement, so battery power is seen as one of the biggest limitations of any unmanned vehicle. While there have been increases in battery technology and power management, computing platforms have also made improvements in operating efficiencies needed to further extend battery life. Increases in power to performance ratios improve system reliability and useful operational time, helping to extend autonomous use value. The processor roadmap identifies continued improvements to power and performance that are now presenting challenges to currently-available computing platforms.

A case in point are new pre-tested rugged box level systems based on Computer-on-Modules (COMs) that use mezzanine modules with a carrier board offering a modular building block solution. These MIL-standard systems facili-

tate UGV development by allowing use and reuse of low power, highly reliable technologies in highly ruggedized enclosures, these small form factor systems add significant value when partnered with processor upgradability.

Purpose-Built Platforms for UGV Classes

Today's UGVs can be powerful force multipliers and intelligent additions to tactical operations. To accomplish these goals, the unmanned roadmap identifies a variety of low-cost, easy-to-operate and flexible vehicle types based on mission profiles. With literally dozens of specific UGVs defined and more on the horizon, each service branch has their own specific strategy for UGV deployments classified under field light, medium and heavy UGVs. Vehicle types cover the spectrum from heavy All Purpose Remote Transport Systems (ARTS) and medium Multi-function Utility/Logistics Equipment (MULE) vehicles to light man-portable vehicles such as the Dragon Runner and ultra-small "throwbots". In the case of throwbots, these mighty wonders must be rugged enough to survive being thrown or dropped onto concrete, perform in the

roughest terrain and offer extended battery operation, camera and video capabilities for reliable short-range reconnaissance. Unlike throwbots, medium sized MULEs can be fully or semi-autonomously able to carry several hundred pounds, thus alleviating field personnel or the need for remote control operators.

Uniting them, all UGVs are defined to critically support situational awareness with safety-critical operation, advanced robotics and efficient operator control functionality. This mandates consistently reliable performance from extremely robust computing platforms. To be considered for UGV integration, small form factor systems must be designed specifically to ensure rugged performance that comes from 100% extended temperature screening and being thoroughly tested for a broad range of characteristics as an integral part of the development cycle. Ruggedized computing system characteristics must provide efficient thermal management from components that include a rugged baseboard, power module, fully-sealed housing, appropriate I/O connectors and options for future customized I/O.

Rugged Performance

Rugged by design, today's extended temperature COMs-based computing platforms deliver improved SWaP solutions at less than six pounds that meet many UGV type needs. Integrating the latest Intel x86 COMe modules, new computing platforms enable system performance to easily evolve with processor advancements by swapping out modules, therefore supplying long-term upgradability and maintainability within the Joint Forces definition. In addition to simplifying upgrades and helping developers avoid time-consuming design re-qualification, COMe modules can be switched out without affecting carrier board customization, which gives longer lifecycle support for customized systems. Also, the latest processors deliver high performance that can be integrated into small form factor systems for enhanced UGV image resolution, mission-critical communications and network throughput.



Critical Moments call for Critical Products

Coilcraft CPS has the battle-proven magnetics you need when the mission is on the line

Our critical-grade RF and Power inductors are built to withstand the most punishing conditions imaginable, including extreme temperatures, thermal shock, G-forces, EMI and vibration.

- Tin-lead (Sn-Pb) terminations for the best possible board adhesion. RoHS terminations also available.
- Extended temperature ranges (-55°C to +200°C)
- Vibration testing to 80 G / shock testing to 1000 G

We also offer comprehensive product testing and validation services in accordance with MIL-STD-981 and EEE-INST-002, as well as custom screening to your electrical and physical specifications.

Learn more about how our battle-tested components will keep your mission on target. Call or visit us online today!



800.981.0363 847.639.6400 www.coilcraft-cps.com

Free Info at <http://info.hotims.com/61061-710>



Cov

ToC



Importance of SWaP-C

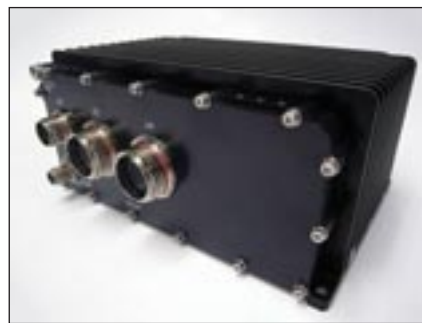
UGV designs demand continual power improvements without adding additional size, weight and heat to the equation. Thermal management is a huge requirement the smaller the system is. Overheating degrades the integrity and reliability even within the well-designed system. Careful consideration of SWaP-C (Size, Weight, Power and Cooling) is a necessity. Ideal thermal design for a UGV would be to implement all of the required system functionality in a chassis that has been pre-certified for ruggedized operation such as one validated to meet the environmental requirements of MIL-STD-810G, rather than one just listed as "designed to meet." This assures the systems' ability to withstand specified extremes of temperature, vibration, shock, salt spray, sand and chemical exposure from a sealed and temperature-controlled enclosure.

Advanced thermal methodologies are needed for a UGV's unique operating

environment that frequently calls for processing-intense operation. Threatening reliable and continuous program execution is higher power consumption and a greater thermal footprint due to reduced idle time of the processor. Because thermal management options are limited in ever-smaller UGV form factors, it is essential that the processor be power conscious and offer efficient system operation to minimize the thermal impact on the UGV.

Future Trends

Future trends will pave the way for increased real-time analysis of multiple situations by single operators, while the UGV performs its assigned mission autonomously. Next-generation communications functionality will need to offer simple plug-and-play payloads that are easily and cost-effectively updated or upgraded with the ability to be Internet of Things (IoT)-enabled linking to world-



COBALT delivers access to extended thermal characteristics 'by design' via a COMe that has been re-engineered and optimized for proven performance in extended temperature applications. As a sealed IP67 system, COBALT is expressly developed to support very rugged applications such as UGV-based computing.

wide enterprise gateway and data center assets. Connecting disparate devices from all authorized DoD systems will help expedite the delivery of mission-critical information for vital real-time decisions. DoD will continue to stress further reductions to size, weight, power and cooling of military platforms to improve mobility and accommodate new payloads while reducing costs.

High-definition sensors will be an ongoing need, and high performance embedded computing (HPEC) systems will be required to support multiple sensor and communications capabilities. For these UGV types, SWaP-C is critical where future HPEC platforms must have a common hardware and software-defined architecture so it meets open standard plug and play and reduced cost goals. HPEC is also seen as addressing future cloud computing, multilayer security and evolving communications requirements.

What is known is that UGVs will have an important and growing role in future ground missions. Enabled by computing technology advancements developed to push the environmental limits of unmanned systems, they are key elements in the support RS JPO UGS Roadmap. Extending the capabilities of ground operations and keeping combat units out of harm's way, UGVs must continue to make mission-critical system survivability priority number one.

This article was written by Joe Eicher, Defense Business Development, Kontron (Poway, CA). For more information, visit <http://info.hotims.com/61061-501>. ✉

Smooth Sealing

The spring-energized Bal Seal® exhibits far less friction than similar oscillating/rotary seals, so designing it into your pod, gimbal, or optical equipment can help you meet torque requirements and improve system uptime, reliability, and precision.

The Bal Seal® spring-energized seal

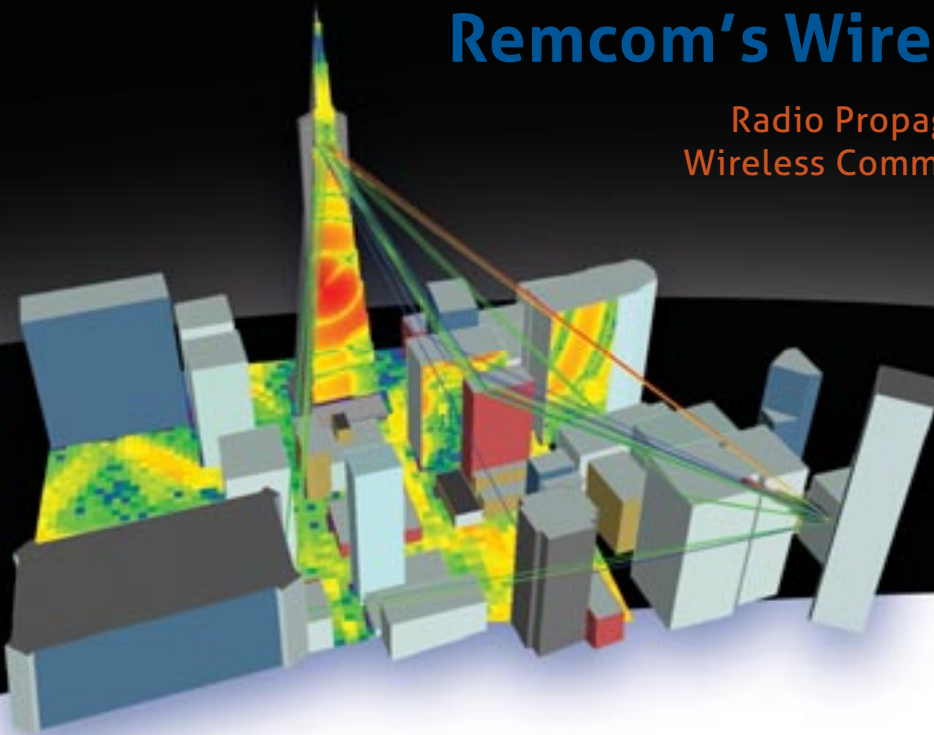
Call or click today, and start designing for tomorrow.

800.366.1006
www.balseal.com

BAL SEAL®
ENGINEERING, INC.

Remcom's Wireless InSite®

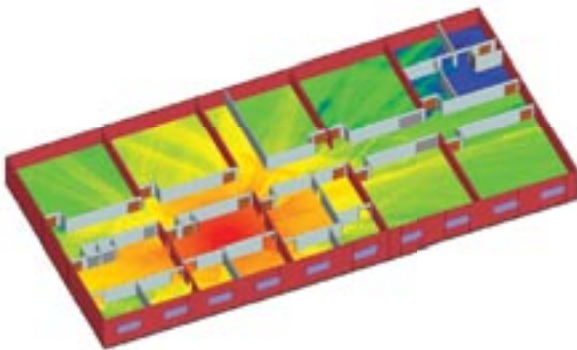
Radio Propagation Software for
Wireless Communication Planning



Wireless InSite is a suite of ray-tracing models for analyzing EM propagation and communication channel characteristics in complex urban, indoor, rural and mixed path environments.

Wireless EM Propagation Capabilities for a Variety of Applications

- 5G MIMO simulation
- Indoor WiFi
- Moving vehicle or aircraft
- LTE and WiMax throughput analysis
- Tower placement for urban coverage
- Ad-hoc and temporary networks
- Base station coverage analysis
- Microcell coverage
- Wireless backhaul stations



See all the latest
enhancements at

www.remcom.com/wireless-insite-features >>>

REMCOM®



+1.888.7.REMCOM (US/CAN) | +1.814.861.1299 | www.remcom.com

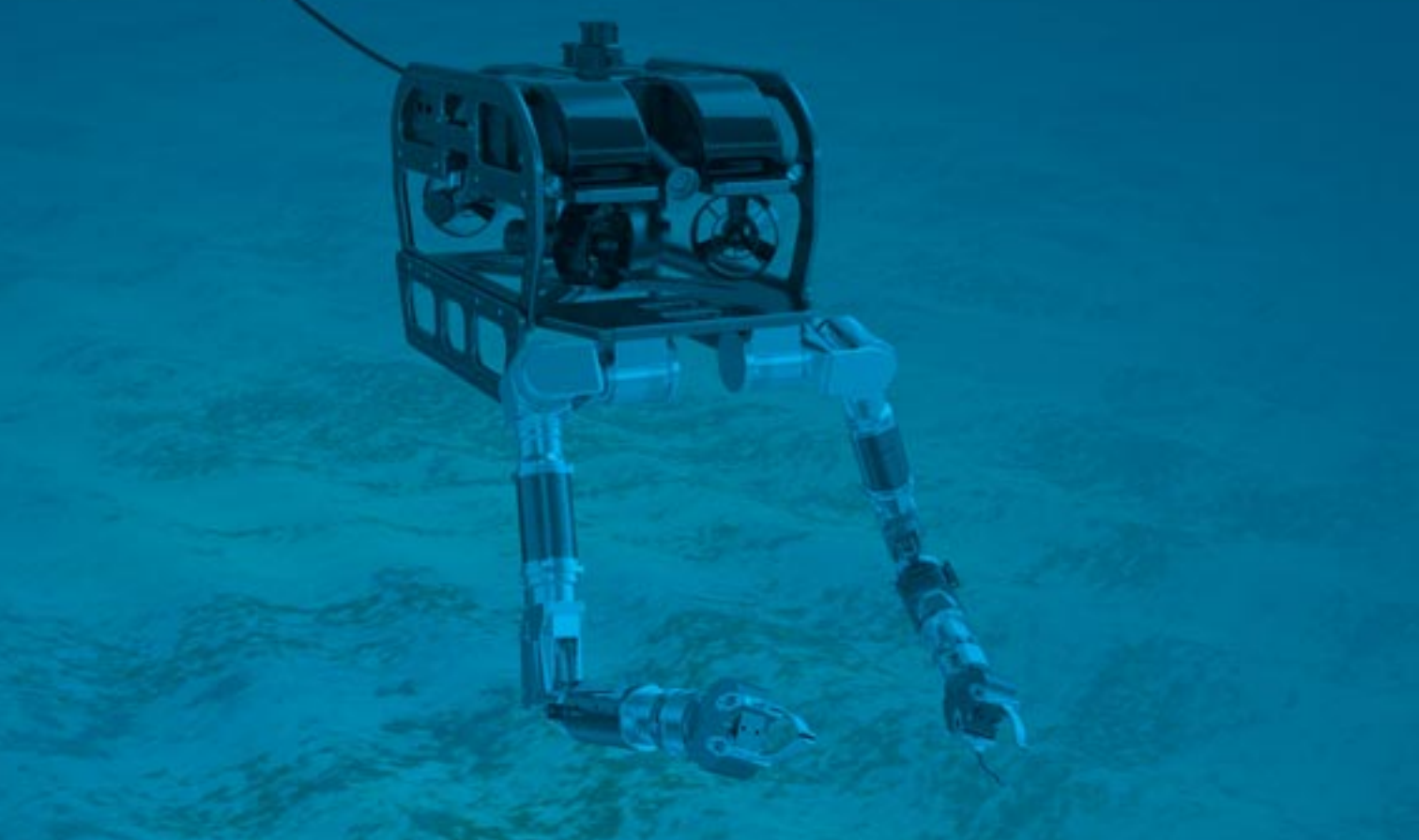
Visit us at IMS 2016, Booth #1114

Free Info at <http://info.hotims.com/61061-712>



Cov

ToC



Bi-manual Dexterous Manipulation for **Maritime Explosive Ordnance Disposal**

Since 2001, there has been a proliferation of robots within the U.S. military to assist with Explosive Ordnance Disposal (EOD) missions. Ground robotics systems are able to detect and dispose of Improvised Explosive Devices (IEDs) with the help of robotic manipulator arms.

These robotic arms are considered true “mobile manipulators”. Mobile manipulators are designed from the ground up to be power-efficient (running off of standard batteries), lightweight, and rugged enough for the rigors of mobile use. These manipulators are integrated into unmanned ground vehicles to enable operators to interact with their environment and neutralize threats. EOD mobile manipulators are specialized for outdoor environments, possess high strength-to-weight ratios, and are able to perform delicate and precise operations while operating in confined, concealed, and cluttered spaces. EOD mobile manipulators are also controlled using teleoperation because a human must be in the loop to deal with explosive threats.

Unfortunately, IED threats are not limited to ground operations. Waterborne IEDs can be hidden in our ports and waterways. The major challenge for manipulator arm manufacturers today is to come up with a marine variant that can effectively and efficiently perform EOD tasks underwater with low visibility, shifting currents, and corrosive environments.

RE2 Robotics is currently developing two types of underwater manipulator arms with the U.S. Navy’s Office of Naval Research. One is an electro-mechanical system and the other is an inflatable solution that utilizes soft robotics materials. In addition to developing these manipulators, RE2 is also creating novel human-robot interfaces to control high dexterity manipulation systems.

Electromechanical Manipulators

EOD operations within the Navy require Remotely Operated Vehicles (ROVs) that are small enough to maneuver in cluttered or confined spaces. These ROVs have limited space and power, but require dexterous manipula-

tion capability. Hydraulic manipulation solutions, commonly used for underwater applications, are simply too large for these smaller ROVs. Although micro-hydraulics solutions are being researched, these systems are likely to be cost prohibitive in the near term since commercial-off-the-shelf parts are not yet available for hydraulics at that scale. As a result, adapting commonly used electromechanical mobile manipulation actuation for underwater use may be the most viable path for achieving dexterity and strength in a compact, lightweight form. RE2 is now adapting its ground-based electromechanical manipulation technology for use in a marine environment.

Through two distinct but complementary Small Business Innovation Research (SBIR) grants, one with ONR and one with the US Army, RE2 developed a highly dexterous manipulation system (HDMS). The Army system featured a total of 11 degrees of freedom (five degrees of freedom per arm plus a one degree of freedom torso). The Navy system’s dexterity mimicked a human

When Reliability is Imperative™



Abbott Technologies' power supplies and transformers are rock solid. They are built for a variety of applications, both manned and unmanned, on land, air and sea. Our products are designed for the harshest environments of the defense, aerospace, telecommunications and transportation industries.

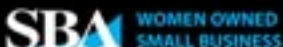
For over 55 years, Abbott Technologies has been designing and manufacturing power conversion solutions with the highest quality standards. Every unit is built to provide uncompromising reliability in the most extreme conditions.

Visit www.AbbottTechnologies.com to see all of our power conversion products.



MBE Minority
Business
Enterprise
Certified

AS9100C / ISO9001



© 2016 Abbott Technologies, Inc. All Rights Reserved. AT2984 3/2016

See our website for more details on our

AC to DC Switchers

Custom, Modified or COTS

200, 500 and 1000 Watts



Rock Solid Reliability for over 55 years.

Abbott 
TECHNOLOGIES™

8203 Vineland Ave | Sun Valley, CA 91352

(818) 504-0644 | Sales (800) 367-8200

Technical Support (818) 504-0644

www.AbbottTechnologies.com

Free Info at <http://info.hotims.com/61061-713>



Cov

ToC



Artist's rendering of RE2's electromechanical underwater manipulator concept.

being (7 degrees of freedom per arm), plus a torso tilt and yaw, totaling 16 degrees of freedom. In addition to its dexterity, HDMS has a 3:1 strength-to-weight ratio. As an example, the Army HDMS weighed 35 pounds and was able to lift 110 pounds.

There were two major innovations related to joint modules which allowed RE2 to achieve this compact and lightweight, yet high-performance, electromechanical capability.

First, RE2 needed a compact, lightweight motor controller solution. Off-

the-shelf motor controllers for DC motors were too large for HDMS. As an example, at the time of development, the smallest motor controller, with the attributes required for controlling HDMS, weighed 82 grams and had a volume of 48mm x 57mm x 38mm. At first glance, this may not appear to be significant. However, 82 grams multiplied by 16 degrees of freedom is approximately 2.9 pounds, which is greater than 8% of the Army's HDMS weight budget. The heavier off-the-shelf controllers located throughout the arm would also require additional structure and actuator torque in order to maintain performance and house the bulkier off-the-shelf motor controllers, further increasing weight.

To overcome this, RE2 used a combination of off-the-shelf components (versus off-the-shelf controllers) and packaged them into a volume of 37mm x 52mm x 15mm that weighed only 17 grams. These resulting controllers significantly contributed to HDMS achieving such a high strength-to-weight ratio in a compact form.

Second, overheating is a major cause of DC motor failures. RE2 custom packaged off-the-shelf drive train components at each robotic arm joint to control the heat dissipation path. With optimized heat dissipation, smaller motors were used to achieve similar performance output as larger motors, serv-

ing as the main driver of the strength-to-weight ratio realized. By using off-the-shelf components for both the motor controllers and joint modules, both reliability and cost savings due to economies of scale were achieved.

Under an ONR research grant, RE2 is now adapting its innovative joint design for maritime use. Preliminary analysis indicates that minor adjustments are needed to support use undersea. Sealing designs will be modified and changes in materials will be required in places. The greatest benefit of the existing joint design is that it can be filled with oil without affecting the main components, allowing for a design where pressure can be compensated more easily than an air-filled solution. Pressure compensation is critical for use at various depths below sea-level. The oil-filled joint modules will also aid in the design of the marine variant of HDMS to be neutrally buoyant, a critical feature for minimizing the impact of HDMS on the ROV.

Inflatable Manipulators

Under an ONR SBIR grant, RE2 is also developing an inflatable high-dexterity robotic manipulator. The inflatable manipulator is based on soft robotics technology. This arm is composed of many cells at each joint with pumps that allow the cell to be filled or emptied with water. As cells are filled, the distal end of the joint rotates "outward", and when cells are emptied, the distal end of the joint rotates "inward." If all cells of all joints are inflated, the arm will be fully extended, whereas if all cells of all joint are deflated, the arm will be fully retracted. The structure between the joints is also made of a soft material that can be filled with water to provide structure. The feasibility of using sea water to operate "structure" or "joint" cells is being explored. When emptied, the arm will stow into the ROV, reducing drag as the ROV swims through the water.

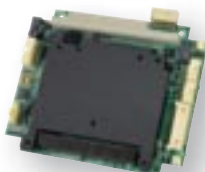
RE2 has also developed an innovative and proprietary joint that would be used at the wrist and shoulder of the arm. This joint uses water to produce a high strength-to-weight joint with continuous roll ability. Ground EOD operations



Conceptual image of an inflatable manipulator arm.



Small Form Factor Computers
Intel® Atom™ E3800 and i.MX6 CPUs
Fanless -40° to +85°C Operation
Mini PCIe and I/O Expansion



PC/104 Single Board Computers
Rugged, Stackable Form Factor
I/O Modules and Power Supplies



Industrial Computer Systems
Off-the-shelf and Custom Solutions
Fanless -40° to +85°C Operation

Single Board Computers
COM Express Solutions
Power Supplies
I/O Modules
Panel PCs



Accelerate Your Product Development Cycle

Speed up time-to-market with embedded solutions from WinSystems. Our industrial computers include expansion options, so customers can expedite prototyping and integration without the burden of CPU or carrier board design. These proven hardware platforms also provide the building blocks to create customized, application-specific designs. Products are in stock and available for immediate shipment from our Arlington, Texas facility.

Let our factory Application Engineers accelerate your capabilities.

715 Stadium Drive | Arlington, Texas 76011
Phone: 817-274-7553 | Fax: 817-548-1358
www.winsystems.com | info@winsystems.com

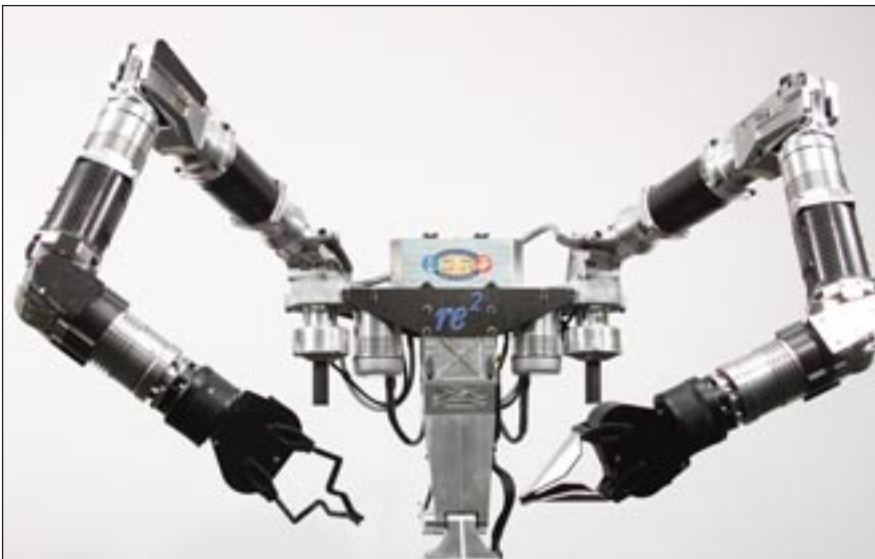


Free Info at <http://info.hotims.com/61061-714>



Cov

ToC



RE2's Highly Dexterous Manipulation System for ground-based EOD operations.



RE2's imitative controller

rely on continuous wrist roll capability. Underwater EOD operations would also greatly benefit from this capability.

Control of Dexterous Manipulators

The Navy wants bi-manual dexterous manipulation for underwater EOD operations, whether it is an electro-mechanical or an inflatable solution in order to execute maritime IED operations more quickly and with less risk than current methods. These tools will harness the intellect and experience of the Navy diver but will increase the "length of their arms" when conducting operations.

Traditional control input devices, such as gaming joysticks (e.g. Xbox), are sub-optimal for controlling dexterous robotic arms. Controlling a 7-degree-of-freedom arm with a gaming controller in order to "fly the end-effector" in Cartesian space is not very effective because the joint and link positions are indeterminate due to the redundant degrees of freedom, which could cause collisions with the arm. After a decade of researching various control input methods for dexterous robotic arms, RE2 has concluded that using an "imitative controller" is the most intuitive input method using technology available today.

An imitative controller is a scaled model of the arm(s) to be controlled. As the operator moves the scaled arm, the remotely located actual arm mimics the motions of the imitative controller. A gripper controller is mounted at the end of the imitative controller, allowing the operator to control the arm's gripper too. When using the imitative controller, not only are operators controlling the end-effector, but they are also controlling all joint positions of the arm. This is important in EOD operations as you may need to control exactly where your elbow is, for example, allowing the operator to prevent all parts of the arm from colliding with obstacles in the environment.

When using only 2D visual feedback from cameras, the imitative controller also provides useful information to the operator – for example, the operator can determine if the two grippers of a bi-manual dexterous manipulation system are touching or perpendicular to one another by simply looking at his or her own hands.

The greatest gauge of the imitative controller's intuitiveness is training time. After a few minutes of training, only hours later, an unskilled operator can quickly become fairly proficient at controlling a 16-degree-of-freedom bi-manual manipulation system.

Conclusion

In order to enable ROVs to truly perform EOD tasks underwater, new innovation is needed. RE2 is researching two viable solutions: electro-mechanical and inflatable. The results of these two research efforts will yield significant data to allow the Navy to assess the pros and cons of each approach so that the most viable solution can be integrated with the fleet of ROVs that will be performing these EOD missions. Regardless of the manipulation solution, an intuitive control device, such as the aforementioned imitative controller, will be critical to allow these dual-arm solutions to be effectively used.

This article was written by Jorgen Pederesen, President & CEO, RE2 Robotics (Pittsburgh, PA). For more information, visit <http://info.hotims.com/61061-503>.

You see:

AN UNMANNED AIRCRAFT



We see:

EXPANDING DEFENSE CAPABILITIES

WITH RUGGED EMBEDDED COMPUTING SOLUTIONS

Kontron is a driving force enabling real world, end-to-end embedded solutions, which play a key role in securing, connecting and managing multiple devices for increased intelligence. Its feature-rich and technically advanced military hardware solutions are proven to innovatively meet harsh environment reliability, survivability and SWAP-C requirements. Achieved through decades of experience engineering rugged, high performance mission-critical computers, boards and rugged enclosures, Kontron excels at delivering COTS application-ready platforms and customized systems specifically designed to accelerate time to market.

Call 1-888-294-4558 to schedule a meeting at AUSVI Xponential.



Visit us at AUSVI Xponential
Hall 1, Booth # 779

POSSIBILITIES START HERE



kontron

Free Info at <http://info.hotims.com/61061-715>



Applying UUV Advances to Safeguard Harbors and Littoral Waters

Advances in unmanned underwater vehicles (UUVs) are providing government agencies and commercial organizations with new capabilities across a variety of mission requirements. However, many underwater vehicles only address specific criteria or support well-defined (and limited) niches. As an example, the Naval Sea Systems Command's (NAVSEA) Littoral Battlespace Sensing (LBS) system includes the LBS-G long-endurance glider to collect

oceanographic data, but also needs the LBS-AUV for military applications.

Requirements for Littoral Areas

The total U.S. shoreline is 95,471 miles according to the National Oceanic and Atmospheric Administration (NOAA), which is nearly the same distance as circling the equator four times. America's diverse shoreline includes busy ports, towering bridges carrying commuters, powerful rivers, and various estuaries. Despite these geographi-

cal differences along the coastline, UUVs and related underwater systems all require the following capabilities to be effective in shallow water missions:

- High maneuverability (to navigate around piers, bridges, oil rigs, etc.);
- Payload flexibility and capacity (to transport and use sonar for example);
- Near real-time data acquisition and/or transmission;
- Portability (easy to transport and deploy rapidly);
- Intuitive operator controls.

Typical operations in these shoreline areas include:

- Bathymetry studies;
- Contraband detection;
- Environmental monitoring;
- Harbor/port security;
- Search and rescue;
- Ship inspection;
- Submerged infrastructure inspection.

Reverse Engineering 20 Million Years of Evolution

The U.S. Department of Homeland Security (DHS) Science & Technology Directorate (S&T) sponsored Boston Engineering to develop a UUV to strengthen the capability to search, inspect, and operate in harsh environments and constricted underwater areas. The Bluefin Tuna, and other pelagic fishes like it, exhibit remarkable swimming performance in all areas: high-speed burst swimming (30-50 knots), high maneuverability (180 de-



Figure 1. Quick BIOSwimmer Deployment



MLS Flatpack capacitors stand up while keeping a low profile

Designed to stand up to the rigors of battle, CDE's MLS Series of stainless steel Flatpack capacitors now handle up to 50 g's of vibration. Vigorously tested in-house to the toughest military and industry standards, Flatpack capacitors are not only rugged, their flat form factor also allows you to fit them into tight spots, cool them, and easily gang them for compact, high bulk storage. Their precision welded construction provides a near hermetic seal that you can bank on up to 80,000 feet.

Bypass the tantalum discussion and put the power of Flatpack capacitors in your hands.

Call or visit our website today for complete details.

www.cde.com

864-843-2277



ENERGIZING IDEAS

**CORNELL
DUBILIER**



Speedy Sample Delivery

Most sample requests can be filled in six weeks or less.
Call today to find out more.



Discuss Your Application Requirements

Our experienced engineers are available to help with your most challenging applications.

Free Info at <http://info.hotims.com/61061-716>



Cov

ToC



Figure 2. BIOSwimmer Addresses a Variety of Requirements in Harbors and Littoral Waters



Figure 3. 2015 BIOSwimmer Demonstration in Fall River, Mass.

gree turns in a single body length), and efficiency (routinely migrate for long distances to 25,000 miles). Boston Engineering's BIOSwimmer UUV is based on this model to deliver a unique and tactically-relevant intersection of speed, maneuverability, and endurance.

Most of the tuna's propulsive motion is concentrated in the rear third of its body. This means that the forward two-thirds of the body is rigid, creating significant payload area (BIOSwimmer can carry about 700 in³ and 23 lbs. of dry payload). BIOSwimmer has a propeller thruster on a flexible tail, giving the vehicle a turning radius of less than one meter. The UUV's propulsion technology also enables BIOSwimmer to approach an object closely and to hold its position while sensors collect data. The five-foot long UUV can be launched quickly and can operate at depths of 0.5 meters to 100 meters.

The BIOSwimmer includes a tow-body-based antenna that operators can use to communicate with the UUV while it is underwater. If the antenna is removed, the BIOSwimmer can collect and store data while it is underwater, and download its results after the mission.

Alternatives for Shallow Water Missions

In addition to UUVs, the most common maritime robotics used in littoral waters are remotely operated vehicles (ROVs) and autonomous unmanned vehicles (AUVs). Here's an overview of their capabilities in this environment.

ROVs are controlled by operators via cables connected from a control panel to the ROV. However, the cables (tethers) are susceptible to getting entangled in underwater plant growth, debris, and other obstacles that are more likely in challenging environments. ROVs can include a video camera, lights, and sonar systems. Common uses include identifying objects in submerged hazardous areas, conducting research, and safeguarding harbors via operations such as vessel hull inspections.

Torpedo-shaped AUVs such as Hydroid's REMUS 100 and Bluefin Robotics' Bluefin-12 have been used to conduct wide area surveys by scanning back and forth in a "lawn mower" pattern underwater. While this may be suitable for covering large areas of water, such vehicles can have some

difficulty turning in tight areas, which can become a severe limitation when navigating objects in shallow waters or adjusting its operational swimming patterns for other missions. Holding position relative to a diver is also very difficult with these systems.

Demonstration Results

The BIOSwimmer has been demonstrated in sea trials at the Port of Houston in 2013, and in Fall River, Mass. in 2014 and 2015. The 2015 exercise and current work are focused on port operations that look for contraband or other dangerous items on ship hulls. The vehicle has been shown to have advantages including the ability to scan a ship 80 percent faster than an ROV, operate at 50 percent of the cost of a dive team, and train port officers or other users in less than one week.

We estimate that port security is enhanced by BIOSwimmer's ability to: inspect an additional 20 percent of a ship versus a competitive AUV, scan three times the number of ships in a harbor during an eight-hour shift vs. an ROV, and provide ease of use (such as launching in <5 minutes from a location of convenience). Boston Engineering continues to refine the BIOSwimmer to incorporate user feedback and technology enhancements. We are currently completing final enhancements to the user interface, communications, and launch/recovery tactics.

This article was written by Michael Rufo, Director of Boston Engineering's Advanced Systems Group (ASG) (Waltham, MA). For more information, visit <http://info.hotims.com/61061-502>.

Real. American. Originals.



Onsrud machinery

has been synonymous with cutting edge innovation for more than a century. It's our ingenuity which has helped manufacture goods all over the globe, and no coincidence companies leading the way in their respective industries have sought us out for our high-quality CNC machining products. We want you to

#ExperienceOnsrud.

Quality craftsmanship. The finest materials & tailor-made components. American ingenuity.



36" dia. Blade

5-Axis

F427HR40H2 - Dual Head High Rail

Compound miter cutting capabilities on 8" thick 7000 series aluminum, paired with 5-axis machining - within a 16' x 28' machining envelope.

Larger sizes available.



(See this machine cutting)



C.R. ONSRUD

AMERICAN-MADE CNC MACHINERY

120 Technology Drive Troutman, North Carolina 28166 (704) 508-7000 www.cronsrud.com

© Copyright 2015, C.R. Onsrud, Incorporated. MMS 01/2106

Free Info at <http://info.hotims.com/61061-717>



Cov

ToC



Designing a Robot to Counter Vehicle-Borne Improvised Explosive Devices

(U.S. Navy photo by Mass Communication Specialist 2nd Class Charles Panter)

The use of Vehicle-Borne Improvised Explosive Devices (VBIED) has increased each year. Current anti-VBIED technology is not only expensive, but requires months or years of training by Explosive Ordnance Disposal (EOD) technicians to operate the equipment. The process of unloading the EOD robot, attaching the detonation wire to the robot, attaching the water charge to the EOD robot, driving the water charge to the VBIED, placing the charge under the vehicle, and then retrieving the EOD robot is a time consuming event. With a typical EOD robot costing \$100k - \$200k, there is a large financial risk to the EOD team if the robot is damaged or destroyed in the process. WM Robots PAWN was developed to offer the EOD technicians another option in reducing the time needed to neutralize the threat and cost of the operation.

Based on EOD Squad feedback, a need was identified for a low cost solution to complement the current procedures for VBIED neutralization. The feedback identified the major design criteria and represented some of the design challenges of PAWN:

- Low cost, expendable;
- Video for non-Line of Sight (nLoS) operation;

- 500 feet of tethered operation, including control, video transmission, and electronic detonation cable;
- Simple operation, minimal training to operate;
- Operation on semi-improved roads with normal debris;
- Deployment in third world countries.

The overall design philosophy was to minimize the Size, Weight and Power (SWaP) of the system. This was one of the major design challenges in development. Computer modeling of the chassis was utilized to simulate the stresses that would be encountered during operation, and allowed for the final design to be as minimal as possible. The requirement of being expendable dictated that the components used could not pose any additional hazards to the scene. By utilizing in-house rapid prototyping of components, Proof of Concept (PoC) and Prototype testing time was reduced, facilitating a reduced development schedule. The design teams approach was to define and design first the size, then the weight, and lastly the power subsystem.

Vehicles utilized in VBIED threats tend to be compact cars, with the IED being placed either in the trunk or backseat of the vehicle. The water charge used to neutralize the VBIED must be placed under the vehicle in these areas for max-

imum effectiveness. The average ground clearance of a compact car is 9" in the trunk section. In order to accommodate for the weight of the IED compressing the suspension of the vehicle, the maximum height was set to 7.5". This height allows the operator to place the water charge directly under the trunk or close to the backseat. This height requirement posed a challenge to the design team, such that the design of the chassis had to have minimal height, securely hold the water charge in place during operation and placement, and have adequate ground clearance for road debris. The chassis was designed using lightweight aluminum, reducing the frame weight, and providing the strength needed for the water charge weight.

To determine the final system weight, 3 areas needed consideration: The water charge system weight, the cable assembly, and the frame. A typical water charge contains 5 gallons of water and an explosive charge with a combined weight of approximately 40 lbs and fixes one part of the total system weight that could not be changed. The requirement of tethered operation, with an operational range of 500 feet, sets another part of the system weight. Design options for the cable assembly were completed and the resultant design of the

Introducing

DEMAND FOR UNMANNED

CATALYST FOR THE MACHINE INTELLIGENCE REVOLUTION
15-16 JUNE 2016, WASHINGTON, D.C.

Small UAS are proliferating with these least capable machines invading the most complex, obstacle-rich environments. The aerospace community, with its rich understanding of both flight and technology is best positioned to undertake the challenge!

—Mike Francis, Chief, Advanced Programs
& Senior Fellow, United Technologies Research Center

This dedicated symposium—held in conjunction with [AIAA AVIATION 2016](#)—brings together stakeholders to identify research and operational challenges and opportunities for the Unmanned Aerial Systems (UAS) community.

You will discover how unmanned aerial systems are catalysts for autonomy, robotics, and machine intelligence, and are changing the nature of civil and military aviation.

Preliminary Program

- The Changing Face of Aerospace: The Impact of UAS on Aviation
- Invention, Entrepreneurship, and Unmanned Systems
- Perspectives on the Future of Autonomous Systems and Technology
- The Autonomy “Dream”
- An Aeronautics Autonomy Roadmap
- Transformation in the National Airspace
- ASSURE: The FAA’s Center of Excellence for UAS Research
- Visions of the Future

The confluence of machine intelligence and aeronautics is the next great revolution in air transportation. There is no better place than the AIAA to bring together diverse groups with a common goal. Our rich history of merging basic science with solid engineering means that AIAA has the right experience to make this happen.

—Richard Wlezien, Professor and Vance and Arlene Coffman, Endowed Department Chair in Aerospace Engineering, and Director, Iowa Space Grant Consortium

Learn More!

www.aiaa-aviation.org/unmannedaero

AIAA
Shaping the Future of Aerospace

Free Info at <http://info.hotims.com/61061-718>



Cov

ToC

CONNECTORS FOR HARSH ENVIRONMENTS



70 YEARS
1946

The M Series Connector is Designed for High Reliability, Military, Robotic, and Commercial Applications

LEMO's M Series Connectors are lightweight, compact, and focused on military engineers that are seeking the MIL-38999 requiring more contacts with less space.

Contact LEMO for more information.

XPONENTIAL 2016
AN AUUSI EXPERIENCE

Visit **LEMO** at Booth # 549
May 2 - 5



LEMO USA, INC
800-444-5366
info-us@lemo.com
www.LEMO.com



NORTHWIRE is
a LEMO Group
Company

Free Info at <http://info.hotims.com/61061-719>



Robotics Technology



PAWN Vehicle-Borne Improvised Explosive Device (VBIED) robot

cable assembly and spooling mechanism added another 16 lbs of weight to the system. The chassis design was finalized such that the final weight, with batteries and electronics, was 8lbs, setting the total system weight to 64 lbs.

With the size and weight parameters identified, the design team could then focus on the motor and power source subsystems. It was identified that a typical skid steering configuration would not be feasible in the design. Typical skid steer in a 4 wheel vehicle encompasses 2 drive wheels and 2 fixed front wheels. When turning a skid steer drive system, the drive wheels are driven in opposite directions, and the fixed front wheels are dragged across the surface, increasing the torque and battery requirements of that system. After evaluating several different steering configurations, the final design for the steering was a modified skid steering scheme that utilizes 2 drive motors and 2 caster front wheels instead of fixed wheels. During a turning maneuver, the caster wheels would rotate to the direction of the turn instead of dragging, reducing the motor torque and power source requirements by 25-40% depending on the terrain.

Design and evaluation of motors was another major design challenge for the team. A wheel diameter of 6" was chosen to give adequate ground clearance, while staying under the 7.5" height requirement. Design calculations showed that, based on terrain, weight, and wheel diameter requirements, that each motor would need a minimum of 21 lbf-in of torque. A suitable motor that meets the torque requirement and with a shaft RPM of 85 was identified. The speed was then calculated to be 1.5 mph, based on motor RPM and wheel diameter. At this speed the time needed to reach the target in a straight line, with an operational range of 500 ft, was calculated to be 3.75 minutes. The design operational time was increased to 15 minutes, to account for obstacle avoidance and nLoS (non-line-of-sight) operations.

The identified motor's power requirements represented 90% of the total calculated power budget. In order to keep the total power budget to a minimum, the electronics and video camera were designed using low power components.

To address the power source options, the operating parameters needed to be carefully considered. The use of lithium based batteries was not an option, due to the fact that the sys-

Aerospace & Defense Technology, May 2016

"THE BEST WAY TO PREDICT THE FUTURE ...IS TO CREATE IT."

—ABRAHAM LINCOLN

Altering the Future

2015 AEROSPACE & DEFENSE CATEGORY WINNER N5 FILO HAZARDOUS GAS DETECTOR

The microsensor arrays on a single chip could replace multiple conventional macro scale gas sensors used in portable multi-gas detectors. These new sensors are small, accurate, low-power, and capable of detecting multiple gases at the same time. This product will enable industrial workers, first responders, and soldiers to quickly detect multiple types of dangerous gases using a mobile device.



"Winning the Create the Future Design Contest award was a big recognition for the N5 team. We have received follow-up inquiries and leads after receiving the award," said Abhishek Motayed, president and founder of N5 Sensors.

WILL YOUR DESIGN BE NEXT?

Start Creating the Future at:

www.createthefuturecontest.com

Create
THE
Future

DESIGN CONTEST 2016

PRINCIPAL SPONSORS



CATEGORY SPONSORS



PRIZE SPONSORS



Cov

ToC



tem is expendable; PAWN would be destroyed with the VBIED during neutralization. Lithium-based batteries would pose a fire hazard to the scene after the neutralization, due to the possibility of shrapnel and debris puncturing the casing of the batteries. After a design review

of available battery technologies, standard C-size alkaline batteries were chosen. Alkaline batteries are readily available worldwide, do not pose a fire hazard if punctured, and the 6000 - 7800 mAh capacity meets the calculated power and operational time require-



PAWN VBIED robot with Boot Banger water disruptor tool used to counter vehicle borne IEDs.

USB Embedded I/O Solutions

Rugged, Industrial Strength USB



USB104[®] Embedded OEM Series

- Revolutionary USB 104[®] Form Factor for Embedded and OEM Applications
- USB Connector Features High Retention Design
- PC/104 Module Size and Mounting Compatibility
- Extended Temperature and Custom Options Available
- Choose From a Wide Variety of Analog, Digital, Serial, and Relay I/O

16-Bit Multifunction Analog I/O, Up to 140-Channels 500kHz

Isolated Digital I/O 16 Inputs and 16 Solid-State Relay Outputs

Digital I/O, Sustained 16 MB/s With 80 MB/s Bursts

ACCES I/O Products' PC/104 size embedded USB boards for OEM data acquisition and control.

OEM System SPACE Flexibility with dozens of USB/104[®] I/O modules to choose from and extended temperature options - Explore the Possibilities!

Saving Space, The Final Frontier

ACCES I/O PRODUCTS, INC.
The source for all your I/O needs
To learn more about our Embedded USB/104[®] I/O boards visit <http://aces.com>
or call 800 326 1649. Come visit us at 10623 Roselle Street San Diego CA 92121

USB PC/104 USB/104 Systems

ments. A drawback of alkaline batteries, while having a large mAh capacity, is the increased internal resistance over nickel-based or lithium-based batteries. This increased internal resistance limits the amount of power the batteries can supply with a large step increase in current. In order to design within this limitation the design team developed drive controls that ramped up the acceleration over time, reducing the step function of motor current.

Several PoCs (proof of concept) were constructed to evaluate the design parameters and initial calculations. The PoCs demonstrated that the initial design calculations for minimizing SWaP were correct, and that a final design that meets the end-user requirements was viable. Prototypes were then developed and tested on a variety of surface conditions and inclines. Testing showed that the caster steering operated nominally with small to medium debris on a roadway, including small potholes. Alkaline battery life testing under simulated real world scenarios resulted in a 12 - 15 minute runtime, depending on terrain, validating the power calculations. Testing was expanded to using NiMH batteries and resulted in a 15-17 minute runtime, on the same terrain that was used for the Alkaline battery testing. The use of NiMH batteries is an option for the operator, if the situation presents a need for a longer run time. The final design was then field tested and all design criteria were validated.

This article was written by Mark Giacobbe, R&D Manager, WM Robots (Colmar, PA). For more information, visit <http://info.hotims.com/61061-504>

Explore the limits. T&M solutions for aerospace and defense.

Today's aerospace and defense technologies demand ever more sophisticated test and measurement solutions to stretch the limits of what is feasible. As a full-range supplier, Rohde & Schwarz offers a broad portfolio that proves its capabilities in even the most demanding applications. Our leading-edge expertise in microwave, RF and EMC helps customers assess performance, optimize platforms and get the most out of systems. Convince yourself.

www.rohde-schwarz.com/ad/sat/fsw



R&S®FSW signal and spectrum analyzer

- Models up to 85 GHz
- Up to 2 GHz analysis bandwidth
- Real-time analysis up to 160 MHz bandwidth
- Pulse parameters at a fingertip
- Unmatched low phase noise of -137 dBc (1 Hz) at 10 kHz offset (1 GHz carrier)



ROHDE & SCHWARZ

Free Info at <http://info.hotims.com/61061-721>



Cov

ToC

Autonomous Underwater Munitions and Explosives of Concern Detection System

AUV uses a magnetometer to detect dangerous submerged munitions.

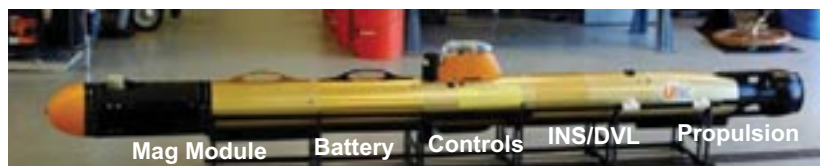
Environmental Security Technology Certification Program, Alexandria, Virginia

The objective of Environmental Security Technology Certification Program (ESTCP) Project MR-201002, Autonomous Underwater Vehicle (AUV) Munitions and Explosives of Concern (MEC) Detection System, was to integrate an untethered and unmanned underwater vehicle with a total field magnetometer for underwater munitions detection and upgrade magnetic noise compensation software to reduce interference from electrical and dynamic influences such as vehicle heading, pitch and roll.

The integrated AUV MEC Detection System consists of a high sensitivity Geometrics G-880AUV cesium vapor magnetometer integrated with a Teledyne-Gavia AUV and associated Doppler-enabled inertial navigation system, acoustic bathymetric, and side-scan imaging modules. Total field magnetic measurements are recorded with asynchronous time-stamped data logs that include position, altitude, heading, pitch, roll, and electrical current usage. Surveys are performed by using pre-planned mission information including speed, height above seafloor or depth, and lane or transect spacing.

Magnetic compensation software was concurrently developed to accept electrical current measurements directly from the Gavia AUV to address distortions from permanent and induced magnetization effects on the magnetometer. Maneuver and electrical current compensation terms can be extracted from the magnetic survey missions to perform post-process corrections.

The AUV MEC Detection System consists of the following primary components: a Teledyne-Gavia model autonomous underwater vehicle, a magnetometer module, and magnetic compensation. The Gavia AUV is a modular underwater robotic system that follows a pre-programmed course, collecting environmental data in situ. Missions are planned using a graphical user interface (GUI) to specify way-



- Fully modular, two person portable
- 2.7 m (long), 77 kg (weight in air)
- 500 m depth rating
- INS/DVL Nav System (Kearfott T-24 SeaNAV)
- Side-scan sonar (900/1800 kHz)
- 2 mega pixel color camera/strobe
- Geoswath phase measuring bathy sonar (500 kHz)
- 10-20 kHz chirp sub-bottom profiler (optional)

Figure 1. Gavia AUV specifications

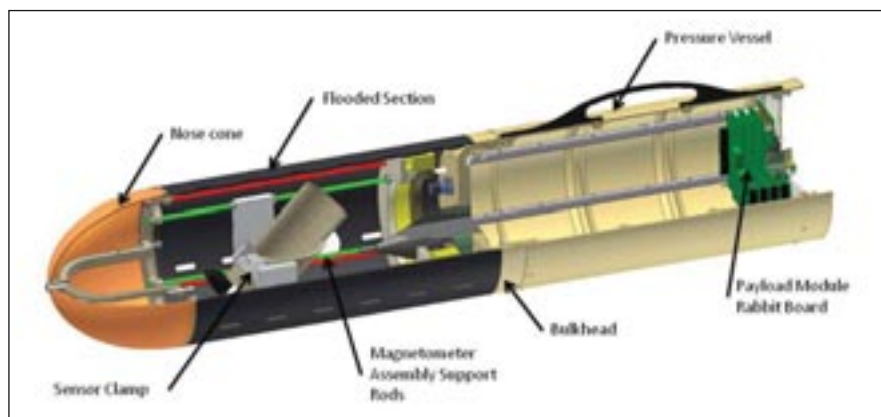


Figure 2. Magnetometer module design

points or survey lines, prescribed depths or altitudes, and desired sensor configurations. The Gavia base vehicle is a mobile sensor platform that can be user-configured on deck for a particular task or operating condition by the addition of one or more sensor, navigation, or battery modules.

The Gavia AUV is navigated by a Kearfott T-24 "SEANAV" inertial navigation system (INS). While on the surface, a Wide Area Augmentation System (WAAS)-capable Global Positioning System (GPS) in the AUV's sail provides po-

sition fixes to the INS. In addition, when within range of the bottom (< 40 meters [m]), an RD Instruments 1,200 kilohertz (kHz) Workhorse Navigator Doppler velocity log (DVL) measures velocity of the vehicle over the seafloor and provides these measurements to the INS.

The Gavia AUV has a maximum depth rating of 500 m. Additional standard sensors aboard the AUV include speed-of-sound, temperature, salinity (derived), dissolved oxygen, chlorophyll-a, and turbidity, as well as a 900 kHz/1,800 kHz side-scan sonar. Other



modules available to the AUV include a sub-bottom profiler, downward-looking camera with strobe, and bathymetric side-scan sonar.

The magnetometer module design schematic is presented in Figure 2. The module flooded section houses the G-880AUV total field magnetometer. The sealed pressure vessel contains the G-880AUV electronics and Applied Physics 539 fluxgate compass (fluxgate). The sensors are interfaced with the magnetometer module circuitry, which is necessary to provide internal electrical power and communication with the vehicle's control system through the AUV microcontroller "rabbit board." A relief slot cut in the flooded section is used to facilitate G-880AUV sensor orientation requirements.

The AUV MEC Detection System showed reliable detection of 60 mm mortars and larger munitions at 1.5 m altitudes, and 75 mm projectiles and larger munitions at altitudes over 2 m. Average offsets between the known and measured locations of seed items ranged between 0.7 m and 1.8 m depending on the mission design and is a function of mission planning software. Offsets were less than 0.5 m where survey lines crossed seed item locations.

This work was done by Art Trembanis and Nicole Raineault of the University of Delaware; Val Schmidt of the University of New Hampshire; George Tait and Misha Tchernychev of Geometrics, Inc.; Brian Junck of Weston Solutions, Inc.; and John Kloske of SRI International for the Environmental Security Technology Certification Program. For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Control category. ESTCP-0001

Power-Line UAV Modeling and Simulation

Computer program helps UAVs avoid collisions with overhead wires.

Army Research Laboratory, Adelphi, Maryland

The Army Research Laboratory Power-Line Unmanned Aerial Vehicle (UAV) Modeling and Simulation (ARL-PLUMS) Software Tool allows a user to model, compute, and analyze the quasistatic electric and magnetic fields around alternating current (AC) power lines. ARL-PLUMS comes with an interactive graphical user interface (GUI), which accesses a compute engine to calculate these fields around these lines due to various ground and line geometries and load conditions. ARL-PLUMS allows the user to rapidly define all significant model parameters and compute the electric and magnetic fields along a UAV path or in a cutting plane. In addition, a set of false-color plots can be created to show the time-varying nature of the fields as a movie. ARL-PLUMS also comes with an application programming interface (API) for accessing some of these features from MATLAB without using the GUI.

ARL-PLUMS uses a right-handed coordinate system. When

RENISHAW
apply innovation™

OVER 40 YEARS OF
BREAKTHROUGH
INNOVATION



Scan the world—you'll never find 5-axis technology like this.

Get ready to take your CMM measurement routine to an entirely new level by harnessing the power of Renishaw's 5-axis technologies. Our exclusive



PH20 5-axis touch-trigger system

designs tame the dynamic errors on your CMM so you no longer need to choose between speed or accuracy. Advancements in head, sensor and control design allow for synchronized movement of the head and machine—

delivering unprecedented measuring speed and flexibility. Whether you need touch-trigger, scanning, non-contact, or surface finish inspection, you can experience breakthrough productivity and reduced lead times by as much as 900%.

Turn your inspection process up to 5!

www.renishaw.com/revo

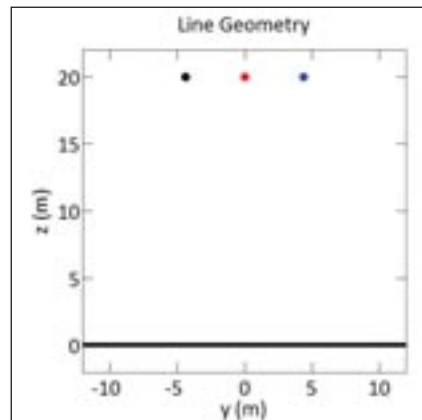
Renishaw Inc Hoffman Estates, IL www.renishaw.com





seated at the computer and looking at the monitor, the positive x direction is out of the screen, toward the user; the positive y direction is to the right; and the positive z direction is up, toward the ceiling. The power lines run parallel to the x axis and positive current runs in the positive x di-

rection. Sea level is always at $z = 0$ m, and all other geometry is referenced to this. An example 2-D power-line model created in ARL-PLUMS is shown in the figure. In this example, there is a single 3-phase circuit 20 m above the ground, and the wires are spaced 4.4 m apart.



Example of 2D power-line model created in ARL-PLUMS

Generally, the electric and magnetic fields around power lines are treated separately and independently as quasi-static entities. This is permissible because at typical power-line frequencies (50 or 60 Hz) or low (e.g., 3rd or 5th) harmonics, the corresponding electromagnetic wavelengths are 1,000–6,000 km. Only the behavior of the fields in the vicinity of the power lines is of interest. This is generally 0–10 km away, which is a fraction of these wavelengths. In this region, coupled electromagnetic effects (such as wave propagation) are negligible compared to the effects of the quasistatic sources, themselves.

In the quasistatic case, the voltages on the lines give rise to an electric field around the lines, and the currents on the lines give rise to a magnetic field around the lines. However, while the currents are the sources of the magnetic field, the voltages do not directly source the electric field. Instead, through capacitive coupling, the voltages induce linear charge densities on the lines and an image charge distribution on the ground, and this charge distribution is the actual source of the electric field. In either case, the total (measured) field at any point is the superposition of the constituent fields from each line source at that point.

Various combinations of the electric and magnetic fields, such as rms magnitudes, derivatives with respect to time and/or distance, ratios, and percent changes, can be used by a UAV to detect

Fill Your Tank

RUN UP TO THREE SUPPLIES IN PARALLEL.



Dawn VITA 62 6U AC/DC Power Supply

RUGGED, RELIABLE AND READY, the Dawn VITA 62 compliant 6U AC/DC **PSC-6265** operates continuously at 580 watts in diverse environments. Standard model is conduction to wedge lock cooled. Operating range -40°C to $+85^{\circ}\text{C}$, nonoperating range -55°C to $+105^{\circ}\text{C}$.

Dawn's **HLD-6262** Holdup Module works in conjunction with our PSC-6265 to overcome 'gaps' or 'glitches' in the normal input power source up to 50 msec, as specified by MIL-STD 704F.

ENCLOSURES BACKPLANES CARD CAGES ACCESSORIES
POWER SUPPLIES VPX PRODUCTS RUSH™ MONITORS

You need it right. You want Dawn.

DAWN
Dawn VME Products®

(510) 657-4444

dawnvme.com



power lines. Each of these quantities has a specific structure around the lines, which can be exploited to determine how close to the lines the UAV is. No matter the direction of approach, the UAV will measure larger and larger

fields as it moves closer and closer to the lines. Once the UAV has detected the lines, it can take action to avoid crashing into them.

This work was done by Ross N. Adelman and David M. Hull of the Army Research

Laboratory. For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Controls category. ARL-0192

Design of a Multi-Segmented Magnetic Robot for Hull Inspection

This flexible, climbing robot could perform hazardous maintenance functions.

Space and Naval Warfare Systems Center Pacific, San Diego, California

Hull, deck plate, and tank inspection for corrosion, deformation, and fractures is a necessary part of ship maintenance to ensure functional integrity and proper operation of the ship. These inspections are labor intensive, expensive, and often dangerous. A multi-segmented magnetic wheeled robot can assist the

surveyors in these tasks.

The Multi-Segmented Magnetic Robot (MSMR) is designed to provide acoustically quiet climbing and turning ability over a typical ferrous hull that often includes discontinuities in the form of protrusions and indentations, especially where hull-plating sections meet. The

key to its effective climbing lies in the design of its wheels and the multi-segmented approach. The wheels are designed to provide maximum magnetic adhesion while the multi-segmented body provides surface adaptability.

The MSMR is composed of the robot modules, linkages, and magnetic wheels

Coherent beam
propagation

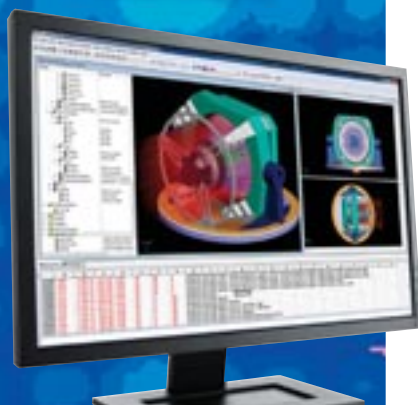
Stray light analysis

Illumination and non-imaging
optical design

Imaging system analysis

Multi-wavelength
characterization

Thermal imagery



Get the right result when FRED software is part of the equation.

FRED® – Photon Engineering's leading optical engineering software – works seamlessly with your optical design and CAD software to achieve your final results quickly and accurately.

Find out why major universities, national labs, and government and aerospace organizations around the world depend on FRED to play an integral role in their scientific and engineering projects.

There's never been a better time to add FRED® software to the equation.

FRED
Optimum

Photon 
ENGINEERING
Illuminating Ideas

520.733.9557 | 310 S. Williams Blvd., Suite 222 | Tucson, AZ 85711
www.photonengr.com



(Figure 1) that provide attraction and traction with the ferrous surface being climbed. The robot modules contain the system electronics, motors, and batteries. The exterior of the robot module protects its contents from water, dust, dirt, and impacts with obstacles. The

flexible linkages allow relative motion between robot modules, so the system can turn, negotiate obstacles, and traverse around corners.

Each robot module contains control electronics, drive modules, and a battery (Figure 2). A plastic prototyping

machine was used to fabricate the robot module chassis with a polycarbonate ABS blend to achieve a rapid turn-around time.

The magnetic wheel provides the attractive force between the MSMR and the surface it is climbing, allowing the robot to traverse vertical and even inverted surfaces. Two magnetic wheel designs were prototyped and tested. The conformal wheel consists of a high-flex elastomer wheel, radial magnet array, magnet locator, rigid hub, and elastomeric tread. The highly flexible structure of this wheel will allow the wheel to deform so that it flattens somewhat where the wheel contacts the ferrous surface. This flattened portion of the wheel creates a larger surface area of contact, increasing both adhesion force and traction.

The flux-plate wheel consists of an elastomer wheel, two flux-plates, flux-plate locators, rigid hub, and an array of magnets oriented parallel to the central axis of the wheel. The flux-plates direct the magnetic flux of the magnet array through the surface climbed, providing adhesion.

The drive module provides the torque to rotate the wheels and move the robot. The main components are the motor, gearbox, output shaft, housing, motor-shaft shock isolator, and bearings.

The drive module was designed to mitigate the effects of large shock loads when the robot falls and lands on the wheels. If the wheel experiences an impact force, the radial loads are distributed through the output shaft to the drive module housing and back to the robot chassis instead of to the gearbox output shaft.

The linkage, which makes the mechanical connection between the robot modules, must be flexible to allow the robot to turn and maintain wheel contact with the ferrous surface being climbed. It must also be able to transfer push (compressive) and pull (tension) forces between the robot modules so they can work in concert to overcome obstacles greater than the capability of any one robot module.

The electronics are grouped into four major categories: power, processing,

**PRECISE, UNIFORM HEAT
EXACTLY WHERE YOU NEED IT.**

HEATRON

Cartridge Heaters

Etched Foil and Wire Wound Heaters

Thick Film Heaters and Circuits

**Endlessly inventive solutions
to complex heating problems.**

**Request a quote:
(913) 651-4420**

Heatron, Inc.
3000 Wilson Avenue, Leavenworth, KS 66048
ISO 9001:2008 - Made in the USA

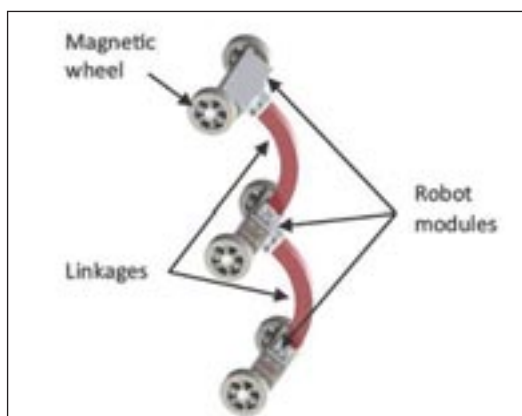


Figure 1. MSMR system overview

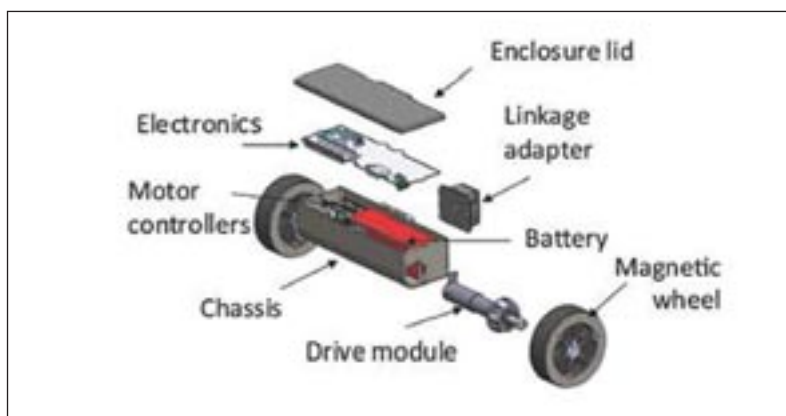


Figure 2. Exploded view of the robot module

sensing, and output. The power group consists of the battery and circuitry to manage and distribute power throughout the system. The processing group consists of the processor, radio, and circuitry to distribute communications. The sensing group includes the wheel

encoders, linkage encoders, camera, and future payloads that may be added to gather information. The output group consists of the motors and motor drivers.

This work was done by Aaron Burmeister, Narek Pezeshkian, Kurt Talke, Saam Ostovari, H.R. Everett, Abraham Hart, Gary

Gilbreath, and Hoa G. Nguyen of the Space and Naval Warfare Systems Center Pacific. For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Control category. SPAWAR-0005

ULBRICH STAINLESS STEELS & SPECIAL METALS, INC.

Introducing Braided EMI Shielding Technology

ULBRICH'S WIRE GROUP OFFERS INNOVATIVE AND ADVANCED WIRE SOLUTIONS TO SUPPORT THE AEROSPACE & DEFENSE INDUSTRY

ENHANCED PRODUCT PERFORMANCE ADVANTAGES:

- » Precision Tolerances and Mechanical Properties
- » Minimum Weight and Maximum Strength
- » Excellent Corrosion Resistance
- » Increased Conductivity
- » Resistance to Fatigue

SPECIALLY DESIGNED ALLOY COMBINATIONS:

- » Nickel Clad Stainless
- » Nickel Plated Copper Clad Aluminum
- » Nickel Plated Stainless
- » Stainless Clad Copper



(800) 243-1676
ULBRICH.COM



A Modular Approach to Video Designation of Manipulation Targets for Mobile Manipulators

This process enables remote manipulation of objects using a 2D video feed.

Naval Surface Warfare Center Indian Head EOD Technology Division, Indian Head, Maryland

Currently fielded EOD (explosive ordnance disposal) robots are limited in terms of both mechanical ability and autonomous capabilities when compared to the current state-of-the-art in mobile robotics. To combat this problem the Joint Service EOD Program is developing the Advanced EOD Robot System (AEODRS). AEODRS consists of three system variants that vary in size: small for dismounted operations, medium for tactical operations, and large for base/infrastructure operations. Differing from past EOD UGV development efforts, these robots will be designed under a modular architecture consisting of several capability modules that are to be developed separately.

Both the medium and large variants will incorporate heavy-duty, high-degree-of-freedom manipulators that can be cumbersome for operators to maneuver even with the help of high-tech controllers. As such, there are requirements for several semi-autonomous behaviors, one of which is the ability for the operator to designate an object through a 2D video feed and have the manipulator autonomously move to the object but not grasp it.

The few requirements needed to use this procedure are: the robot is equipped with an encoded serial manipulator;

the robot has some type of 3D sensor (e.g. stereo camera, structured light, or scanning lidar) that can be aimed to anywhere in the arm's workspace; the robot has at least one video camera that transmits to an Operator Control Unit (OCU) and there is no maximum number of cameras; and there are known or encoded kinematic chains connecting the robot's arm, cameras, and 3D sensor.

A brief high-level overview of the system is shown in the figure, which depicts a hand grenade inside of a backpack being designated from a 2D video feed. The 2D pixel position is transformed into a 3D point using the forward kinematics of the robot. Inverse kinematics is used to solve the joint angles required to get the end effector to that point. Finally the manipulator is commanded to those joint values.

The exact process is as follows:

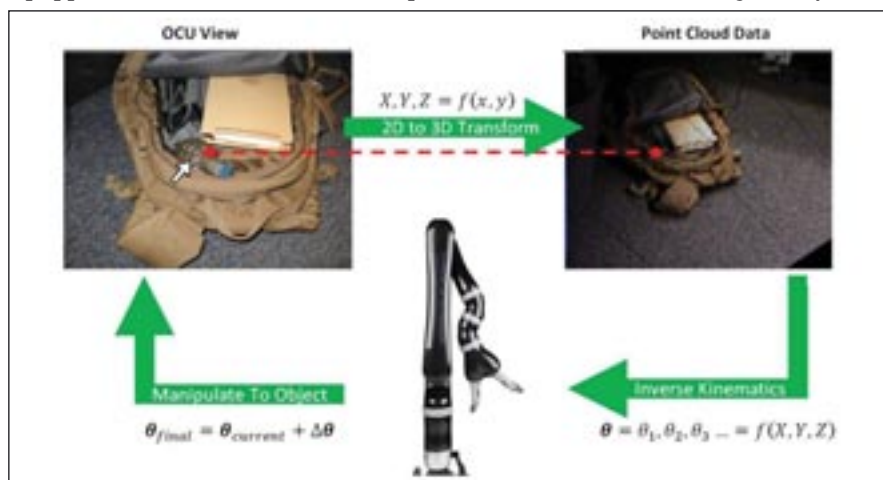
1. Video feeds are sent from the robot to the OCU.
2. The user selects an object from the OCU display.
3. The pixel position corresponding to the selected object is sent to robot computer and transformed into a ray.
4. The 3D location of the point of interest (POI) is estimated using the ray, loca-

tion of ground, and arm's workspace.

5. The pan/tilt mechanism points at the estimated point of interest.
6. A point cloud is constructed by tilting the lidar up and down.
7. The point cloud is inserted into an octree format.
8. The ray from step 3 is casted into the octree to find the 3D location of point of interest.
9. Inverse kinematics are used to compute the pose of the arm required to get close to point of interest.
10. The arm motors are commanded to that pose.

Some mobile robot systems are equipped with a 3D sensor that constantly scans the environment 360° around the robot to carry out obstacle detection and path planning tasks. For such systems, it is likely that any pixel a user selects from any camera will correspond to a 3D point that has already been recorded. However, if a 3D sensor is only onboard for manipulation tasks, the sensor only needs to scan when the user asks for semi-autonomous manipulation. Or, if the 3D sensor has a limited field of view, it may not be currently pointing at the POI at the time the user selects it. For either of these cases there needs to be a plan in place to enable the 3D sensor to scan the area of interest quickly rather than waste time doing a full hemispheric scan. For this to happen, the location of the POI needs to be approximated using the forward kinematic model of the robot (e.g. a pan tilt mechanism) and the camera's intrinsic parameters. Then the 3D sensor can center its scan on this estimated location to get the true position of the point of interest.

This work was done by Aaron O'Toole and Jessica N. Jones of the Naval Surface Warfare Center Indian Head EOD Technology Division. For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Control category. NSWC-0001



High-level overview of the AEODR system

Two-Dimensional Distributed Velocity Collision Avoidance

Sophisticated algorithms prevent mishaps between autonomous unmanned vehicles.

Naval Air Warfare Center Weapons Division, China Lake, California

As the number of autonomous vehicles continues to increase for both commercial and military applications, collision avoidance algorithms are of the utmost importance to successfully execute missions in dynamic environments.

One approach is the two-dimensional (2D) version of the Automated Velocity Obstacle Collision Avoidance (AVOCA) system, a collection of velocity obstacle (VO)-based collision avoidance algorithms. The primary goal of the AVOCA system is to achieve cooperative collision avoidance by dynamic entities in the problem space (agents), performed in a distributed fashion with minimal communication requirements. The algorithms used in AVOCA achieve implicit cooperation through their application and require only basic information (i.e., position and velocity) information on other agents for their calculations.

The AVOCA system uses basic VOs, truncated VOs, reciprocal velocity obstacles (RVOs), hybrid reciprocal velocity obstacles (HRVOs), and Clearpath. Generally, a VO is a geometric region (typically an infinite triangle) that is calculated using two agents in the problem space, a source agent (Asrc) (i.e., the agent that is being guided by the algorithm), and another agent (Aoth). The VO region defines the set of all points that, if used for the endpoint for Asrc's velocity vector, will result in a collision between the two agents at some point in the future.

To perform its avoidance calculations, AVOCA builds basic VOs, RVOs, and HRVOs for all other agents in the problem space. The constructs are built using the velocity and position of each agent, so these data items are required by AVOCA. Basic VOs assume no inter-agent cooperation. When used unmodified, this means that Asrc assumes full responsibility for performing the collision avoidance between the two agents. The AVOCA system uses bound Euclid-



Automated Inspection

Verisurf programs and operates CMMs faster, easier and at a lower cost with its Model-Based CAD measurement platform; supporting all types and brands of coordinate measuring machines. Verisurf's open system strategy increases inspection flexibility, eliminates bottlenecks and reduces training and support costs.

Call today for the name of your nearest dealer or to arrange a demo.

Dealer Inquiries Invited.

VERISURF
3D Measurement Solutions
www.verisurf.com • 866-340-5551



FREE Verisurf Software Learning Edition

Students, educators and customers can now learn all the features of Verisurf Software for manufacturing inspection, tool building and reverse engineering.

For more information and software download visit <https://www.verisurf.com/learning-edition-registration>.

Not for commercial use.



Avionics Databus Solutions

Modules – Software – Systems

Solving all your Avionics Databus Needs – Right on Target.

www.aim-online.com



MIL-STD-1553

STANAG3910/EFEX

ARINC429

AFDX®/ARINC664P7

Fibre Channel

ARINC825

ARINC818

AIM Contacts:

AIM USA LLC - Trevoze, PA
salesusa@aim-online.com

AIM GmbH - Freiburg
sales@aim-online.com

AIM GmbH - Munich Sales Office
salesgermany@aim-online.com

Free Info at <http://info.hotims.com/61061-728>

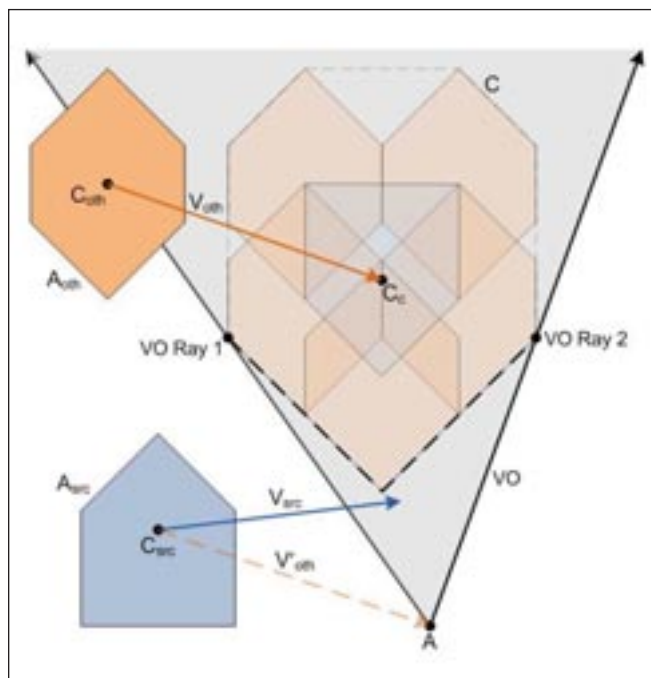
www.hunterproducts.com



MICRO-METALLIZER PLATING PENS MIL & QQ Standards GOLD 14K, 18K, 24K, SILVER, RHODIUM, PALLADIUM, NICKEL, COPPER, TIN, BLACK NICKEL, AND CHROME COLOR PENS AVAILABLE.

Environmentally friendly, these low-cost disposable applicators permit instantaneous selection from a variety of plating possibilities without the preparation of solutions. Specially formulated compounds and can be used for contact repair, prototype development work, electronic instrument repair, medical instrument repair etc.

Hunter Products Inc.
 792 Partridge Drive, P.O. Box 6795
 Bridgewater, NJ 08807-0795
 800 524 0692 • Fax: 908 526 8348
sales@hunterproducts.com

Example VO construction

ean vectors (i.e., vectors in which both the base and end point are used), rather than the more commonly used free vectors (i.e., vectors in which just the magnitude and angle are relevant).

This work was done by Josh L. Wilkerson, Jim Bobinchak, Michael Culp, Josh Clark, Tyler Halpin-Chan, Katia Estabridis, and Gary Hewer of the Naval Air Warfare Center Weapons Division. For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Control category. NAWC-0001

Undersea Communications Between Submarines and Unmanned Undersea Vehicles in a Command and Control Denied Environment

UUVs could provide critical data link between submarines and command center.

Naval Postgraduate School, Monterey, California

Nuclear powered submarines can stay submerged for days at a time and only have to come to periscope depth (PD) for communications and minor house-keeping items. Submarines are completely reliant on satellites for communica-

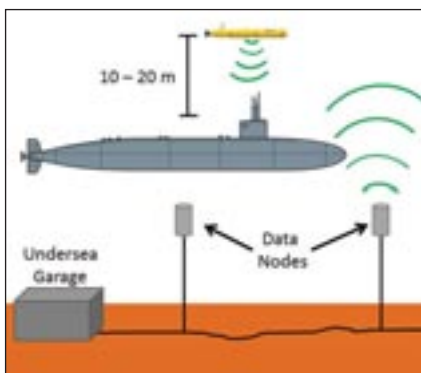


Figure 1. Interface between submarine, UUV, and data nodes.

tions and orders from their commanders ashore. A command and control denied environment (C2DE) is an area in which communications are jammed or degraded. There is no technology currently available that allows submarines to conduct communications in a C2DE. The only method currently available is for the submarine to navigate to unaffected waters, conduct all of its communications, and then to travel back to the C2DE, wasting valuable time and possibly compromising the submarine's mission.

The Navy's current communication workhorse is the Milstar satellite network. The system consists of five satellites, two Milstar I, and three Milstar II, which have peak data transfer rates of 2400 bits per second (bps) and 1.544 mega-bits per second (Mbps), respectively. This low data rate means that the submarine has to maintain PD for long periods of time, thus exposing itself to unnecessary risk of detection or collision.

New line-of-sight (LOS) communication technologies, like the blue-green laser, are being developed to overcome the communications vulnerability. The laser works in much the same way as a fiber optic cable, with the medium for data transfer being the air instead of the cable. As long as there is a clear LOS between the transmitter and receiver, high data transfer rates are available. Recent tests revealed a 99% reliable data stream at 90 Mbps at 10 km distance.

The technology also works under water, but the range of transmission is

greatly diminished. Data transfer rates of between 7 and 10 Mbps with a 99.99% success rate were observed, but only in the 10 to 20 meter range. This initially appears to pose a difficult challenge, but with the application of an underwater network of data transfer

nodes and UUV carriers, short data transfer ranges may not be an insurmountable issue.

The Navy is investing heavily in the use of unmanned underwater vehicles (UUVs) to help in areas including mine warfare, oceanography, sal-



When it really matters.

The astronautics industry also counts on our drive systems. These can be found, for example, in the NASA rover Opportunity, which has been in action on Mars since 2004.

The maxon product range is built on an extensive modular system, encompassing: brushless and brushed DC motors with the ironless maxon winding, planetary, spur and special gearheads, feedback devices and control electronics.

maxon motor is the world's leading supplier of high-precision drives and systems of up to 500 watts power output. Rely on the quality of the highly specialized solutions which we develop with and for you. www.maxonmotorusa.com

maxon
PRECISION MOTORS

maxon motor
driven by precision



vage, and rescue operations. Used in conjunction with the blue-green laser, the UUV would be able to meet all of the submarine's communication needs without the submarine ever coming to PD. The laser-fitted UUVs

relay information from anchored data nodes to a sensor in the submarine's sail. Figure 1 illustrates how this would work.

The modeled UUVs will patrol a linear area recharging at the completion of

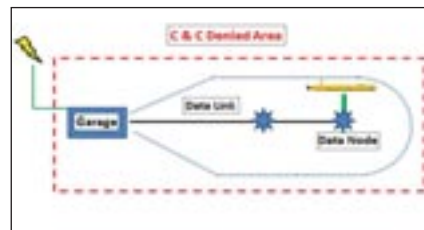


Figure 2. UUV patrol route

each patrol at an undersea garage. The garage will receive continuous updates from a sensor placed outside of the C2DE, but tethered to the garage. The garage will update the UUVs while they recharge and relay its continuous data feed to data links spaced along the patrol route of the UUVs. The UUVs will then download updates while passing by the data links to refresh their current information (Figure 2). When a submarine comes in contact with one of these UUVs, it will slow down and allow the UUV to approach. The submarine will then receive the UUVs broadcast via LOS blue-green laser transmission from above.

This configuration is modeled in agent based modeling software called Map Aware Non-uniform Automata (MANA). The scenarios consist of a submarine entering a network of UUVs and data nodes and determining how long it takes for the UUV to find and transfer data to the submarine, and the latency of the transferred data. Factors varied in the modeling include: the number and speed of the UUVs, the number of data nodes, the range at which the UUV and submarine detects each other, and how long the data transfer takes to complete. Thirty-six separate models are required to capture all of the discrete combinations of number of UUVs and data nodes, as well as the UUV's speed.

This work was done by Forest B. McLaughlin of the Naval Post Graduate School. **For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Robotics, Automation & Control category.** NRL-0064

Metal Bellows for Aerospace and Defense

Lightweight | Tight Tolerances | Custom Designs



Featuring Premium Alloy FlexNickel™

Applications:

- Actuators
- Air Speed Measurement
- Altimeters
- Barometers
- Oxygen Systems
- Cryogenic Cooling Systems
- Landing Gear Systems
- Pressure and Temperature Instrumentation
- Valve Controls
- Waveguides
- And more!



Contact Us for Engineering Assistance.

ISO 9001:2008 Certified
RoHS Compliant
ITAR Certified



servometer.com



Servometer

MW Industries, Inc.



Application Briefs

Unmanned Helicopter

Schiebel Group
Vienna, Austria
+43 (1) 546 26-44
www.schiebel.net

In five months of operation, the NGO Migrant Offshore Aid Station (MOAS) saved over 8,800 lives in the Mediterranean. By spotting and monitoring distressed vessels, Schiebel's Unmanned Air System CAMCOPTER® S-100 assisted in the rescue and contributed significantly to the success of the mission.

Thousands of refugees have tragically drowned while crossing the world's deadliest border. Already back in 2014, MOAS and Schiebel rescued more than 2,800 men, women and children. Between May and the end of September 2015, the NGO's Phoenix, a 40-meter long ship on which the CAMCOPTER® S-100 is stationed, again patrolled the Mediterranean. Under the guidance and coordination of Rome's Maritime Rescue Coordination Centre, to date over 11,600 lives have been saved since the start of the operation in 2014.

The S-100 proved to be a big asset during the operation as it can locate refugee boats by day and night, even in rough sea conditions and at long distances. The camera of the unmanned helicopter delivers daylight and infrared video in real time to the MOAS team. Due to the high quality of the footage, it is not only possible to locate a small ship, even if it is miles away, but also to



identify whether it is a fishing boat or a ship in danger.

Operated by Schiebel staff and largely sponsored by Schiebel, the unmanned helicopter serves to considerably extend the reach of the vessel beyond the horizon to increase its area of influence.

MOAS is the first civilian organization to use these high-tech helicopters for humanitarian purposes, allowing them to significantly reduce the death toll. Following the conclusion of 2015's Mediterranean mission, the NGO planned to continue to monitor the situation closely and resume its operation in 2016.

For those unfamiliar with the organization, MOAS is a group of international humanitarians, security professionals, medical staff, and experienced maritime operators who have combined their resources to help prevent further tragedies at sea. They are passionate about the plight of those seeking a better life and facing dangerous challenges as they try to find a life free from violence. The organization is based in Malta.

For Free Info Visit

<http://info.hotims.com/61061-507>

Mini-Unmanned Aircraft System

Elbit Systems
Fort Worth, TX
817-234-6600
www.elbitsystems.com

Elbit Systems has developed the Skylark3, a new autonomous mini-Unmanned Aircraft System (UAS), best suited for brigades and divisions in "beyond the next hill" reconnaissance, counterinsurgency and force protection

missions, as well as for use in a range of civil applications, such as border and coastal security and anti-terror operations. The new system has already been selected by an undisclosed customer.

Leveraging the proven technology and operational experience of the Skylark family of mini-UAS, Skylark 3 offers a wide range of system enhancements, including a significantly larger range (more than 100 km), flight endurance (up to 6 hours) and payload capacity (up to 10 kg). Launched via a pneumatic launcher, mounted either



Cost Effective Solutions
for your most Complex Manufacturing Requirements

- Precision Metal Stamping (High and Low Volume)
- Welded & Mechanical Assemblies
- Complex CNC Machining
- Close Tolerance Grinding
- Tooling, Fixtures and Gages
- Laser Cutting and Welding
- Rapid Prototyping
- Wire EDM



LYONS
Innovative Manufacturing Solutions

sales@lyons.com
1.800.422.9363
www.Lyons.com



Can your electrically conductive adhesive withstand the cold?

ONE PART EPOXY SUPREME 10HTS

Excellent electrical conductivity

Volume resistivity
< 0.006 ohm-cm



High physical strength



Tensile strength
> 5,000 psi

Cryogenically serviceable

Serviceable
from 4K to 400°F



NASA low outgassing



Passes
ASTM E595

Easily dispensed



Silver filled



MASTERBOND®
ADHESIVES | SEALANTS | COATINGS

40 YEAR
ANNIVERSARY

Hackensack, NJ 07601 USA
+1.201.343.8983 • main@masterbond.com

www.masterbond.com

Free Info at <http://info.hotims.com/61061-733>

YOU'LL FIND US WHERE the ACTION IS!



Rod Ends and Spherical Bearings designed and manufactured to **Aurora's** exacting standards for quality and durability.

Registered and Certified to ISO-9001 and AS9100.

From economy commercial to aerospace approved,
we've got it all !



Aurora Bearing Company
901 Aucutt Road
Montgomery IL. 60538

Ph: 630-859-2030

Complete library of CAD drawings and 3D models available at:
www.aurorabearing.com



on the ground or on a vehicle, Skylark 3 offers upgrades such as improved payloads with better target detection, classification and surveillance capabilities. These deliver Electro Optical/Infrared (EO/IR) video and photographic imaging in both day and night operations and in adverse field conditions. The aerial vehicle incorporates an electric motor which reduces sound signature and enables operating over long distances and at high altitudes. It has a 4.8 m wingspan, a maximum takeoff weight of 45 kg, and a service ceiling of 15,000 ft.

To support interoperability, Skylark 3 uses the same technologies found in other Elbit Systems' UAS. In addition, through a shared GCS, two Skylark 3 vehicles can be assigned to the same mission simultaneously, meaning a consistent target acquisition is maintained from two aspects. This also offers ground forces the ability to significantly extend the flight endurance of their mission by performing UAS hot-swap.

For Free Info Visit <http://info.hotims.com/61061-509>

Predator Mission Aircrew Training Systems

L-3 Link Simulation & Training
Arlington, TX
817-619-2000
www.Link.com

L-3 Link Simulation & Training (L-3 Link) was recently awarded a contract option from the U.S. Air Force to build 34 new Predator Mission Aircrew Training System (PMATS) simulators. The contract was awarded by the U.S. Air Force's Life Cycle Management Center at Wright-Patterson Air Force Base.

The new PMATS simulators will be used to train Predator and Reaper pilot and sensor operator crews. PMATS training devices, in addition to associated equipment and systems, will be delivered to 15 installations between the U.S. Air Force and U.S. Air National Guard.

The L-3 Link-developed and -produced PMATS training solution has been supporting training for the U.S. Air Force and U.S. Air National Guard since initial devices were delivered in 2007. L-3 Link, under previously awarded contracts, has fielded or is continuing to build 33 PMATS devices. This new



award for 34 additional PMATS simulators will result in L-3 fielding a combined total of 67 Predator and Reaper trainers to support the services' crew training objectives.

Under this contract option, L-3 Link will integrate its simulation environment solution with ground control stations supplied by the U.S. Air Force. L-3 Link's simulation solution combines a physics-based image generator, Synthetic Automated Forces generator, instructor station, and other training system hardware and software. PMATS training devices create a high-fidelity environment that simulates aircraft performance, weapons, sensors, communications, data link operations, emergencies, degraded video feeds and environmental conditions. On these simulators, Predator and Reaper crews undergo initial qualification, mission qualification, continuation and mission rehearsal training.

For Free Info Visit <http://info.hotims.com/61061-511>



Field Swappable Underwater Storage Unit

SECO srl
Arezzo, Italy
+39 0575 26979
www.seco.com

The Centre for Maritime Research and Experimentation (CMRE), an executive body of NATO's Science and Technology Organization (STO), is an established scientific facility that organizes and conducts research and technology development centered on the maritime domain.

The "Collaborative Autonomous Mine Countermeasures CA-MCM" is one of the main projects at CMRE, aiming at increasing the capabilities of autonomous underwater vehicles (AUVs) by using Synthetic Aperture Sonar (SAS) to quickly and reliably detect, classify, and localize mines. This implies the use of high performance, efficient processing systems installed in underwater robots working in real-time.

CMRE has been using CPU boards produced by SECO s.r.l. since 2013. The Pico-ITX boards (Single Board Computers) are suitable for integration in underwater vehicles where reliability, reduced footprint, low power consumption and computational power are key factors. As of today these boards have been installed on a wide range of vehicles that are part of the CMRE fleet.

One of the best examples of these vehicles equipped with the Pico-ITX boards is the MUSCLE, CMRE major MCM AUV. With a high-resolution, high-frequency synthetic aperture

sonar (SAS) installed, MUSCLE provides superb image quality of objects on the seafloor, and it has a high level of autonomy, thanks to its real-time processing software running on a dedi-

We enable **robotic** excellence.



Advanced Products for Robotics and Automation

CGI Motion enables robotic excellence across a wide range of robotic and automation applications. We deliver electromechanical sub-assembly solutions ranging from medical robotic systems to semiconductor applications. Our team of problem solving engineers and product managers can bring your idea to market on time and under budget. Whether it's an improvement on a current design or groundbreaking new designs, CGI has the know-how and team to enable robotic excellence. Connect with us today to explore what CGI Motion can do for you.



CGI is a proud sponsor of the
FIRST® Tech Challenge.
www.usfirst.org

COPYRIGHT©2016 CGI INC. ALL RIGHTS RESERVED. 0321R



800.568.GEAR (4327)
www.cgimotion.com





A Furukawa Company

Your Optical Fiber Solutions Partner®

Optical Fibers, Cables and Modules for Challenging Applications

Rad Hard GyroSil® PM for Gyroscope Coils

µlinx™ MICRO Cables for Unmanned Craft

FlightLink and FlightGuide® for Avionics Systems

Yb & Er/Yb Optical Fiber and Modules
for LADAR & Directed Energy



SPEAK WITH THE EXPERTS!
New Orleans, LA, USA | 2 - 5 May 2016
Booth #631

www.ofsoptics.com [f](#) /ofsoptics [t](#) /ofso_defense [in](#) /company/ofs [v](#) /OFSoptics

Free Info at <http://info.hotims.com/61061-736>



GAGE BILT

RIVET TOOLS



PNEUMATIC TOOLS

FOR NUTPLATE AND "A" CODE RIVETS



- Cost Saving
- Ergonomic
- No Bleeding
- Light Weight
- Controls F.O.D.

GB54B
with stem
collection bottle



GB55B
with stem
collection bottle



GB50 & GB51
and zippered
stem catcher bag



QUALITY TOOLS SINCE 1956  **MADE IN THE USA**

586-226-1500 solutions@gagebilt.com gagebilt.com



cated high-end GPU-based system and advanced decision-making capabilities. Despite its relatively low TRL (Technology Readiness Level), the MUSCLE unmanned vehicle is regularly tested and successfully utilized in operational Mine Countermeasure (MCM) scenarios in which a very quick turnaround time from mission execution to post mission analysis and very short mission-to-mission downtimes are key factors.

CMRE began developing concepts for allowing a quick data transfer on autonomous vehicles in 2014. The challenges in developing an underwater field swappable storage unit are in the use of unconventional underwater connectors (typically not suited for standard data buses) and the miniaturization imposed by the portability of the system despite its ability to sustain high pressures.

The SECO Pico-ITX boards with two Gigabit Ethernet ports and 2 SATA3 channels combined with their small form factor seemed a possible solution for such applications. The full integration of one of these boards into a small water-tight 300m rated case developed and built at CMRE was successfully accomplished in 2015. The system has then passed multiple bench tests and it is now approaching the field testing stage. The high computational power and the possibility of installing up to 8GB of RAM will allow for some data processing contribution to the overall reduction of the post-mission-analysis time.

The newly built underwater field-swappable storage unit is expected to significantly reduce the mission-to-mission downtime due to the data transfer from hours to minutes. This will make multiple missions in the same day possible and it will bring the operational readiness of the CMRE underwater robots, in particular the MUSCLE AUV, one step further. The quick storage unit swap will also allow the operator to have access to the results produced by the advanced internal processing unit of the MUSCLE AUV during the mission execution.

For Free Info Visit <http://info.hotims.com/61061-510>



Reconfigurable Integrated-Weapons Platform

Moog Inc.
East Aurora, NY
716-805-2008
www.moog.com/rwip

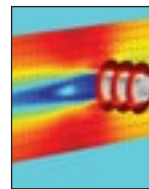
Moog Inc. Space and Defense Group and its defense-industry partner, DRS Technologies, recently introduced a new Reconfigurable Integrated-weapons Platform (RIWP) during a live fire demonstration at Redstone Arsenal.

Engineered with many advanced features, the RIWP includes high-performance target acquisition technology and superior pointing/stabilization accuracy ensuring U.S. and Allied forces see first, engage first and achieve mission success. Additionally, it offers a wide range of platform weapon system interoperability and allows the warfighter both reload under armor and in-field weapon reconfigurability. The RIWP installs easily onto most current and planned U.S. and allied land, sea and air platforms and provides tailored overmatch for any combat situation.

The demonstration event featured both M2 and Mk19 direct fire weapons and Javelin missiles, carrying out ground-to-ground live fire exercises. During the tests, the RIWP fired multiple rounds from an M2 .50 caliber machine gun, grenades from a Mk19 40mm launcher, and Javelin missiles. All of the weapons successfully hit their targets. In addition to the firing event, the RIWP under armor reload and reconfiguration capabilities were demonstrated. All RIWP configurations allow missile variants to be fully armor protected, eliminating the chance for missile damage by debris or small arms fire.

The RIWP accommodates a variety of weapons including direct fire, missiles, and non-lethal deterrents, as well as an advanced sensor package. With more than 100 weapon configurations that can be housed on a single platform, the RIWP offers common training and logistics benefits. The RIWP also features highly integrated operator work stations, a network capable architecture, and advanced fire control which has demonstrated an approximately 80% improvement in engagement times for defilade targets.

For Free Info Visit
<http://info.hotims.com/61061-508>



COMSOL MULTIPHYSICS FOR SIMULATION APP DESIGN

COMSOL Multiphysics delivers tools for modeling, simulation, and application design. With the

Application Builder, simulation specialists can build and share simulation apps within organizations, from design and development to production and testing. See what's new in simulation technology at comsol.com/release/5.2

COMSOL, Inc.

Free Info at <http://info.hotims.com/61061-738>



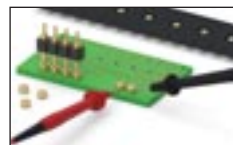
EPOXY FEATURES CRYOGENIC SERVICEABILITY

Master Bond Supreme

10HTF-1 is a one part system with easy processing and a smooth paste consistency. It has fine dimensional stability and brilliant physical strength properties, particularly tensile lap shear and peel strength of >3,200 psi and 20-25 pli, respectively. Supreme 10HTF-1 is capable of withstanding aggressive thermal cycling. <http://www.masterbond.com/tds/supreme-10htf-1>

Master Bond

Free Info at <http://info.hotims.com/61061-739>



LOW PROFILE SMT SPRING PIN MATING TARGET DISCS

Mill-Max announces a unique new spring pin mating part. This low profile SMT disc shaped terminal is perfect for applications where vertical space is at a premium. The flat surfaces are ideal for SMT soldering and as the conductive mating surface for spring-loaded pins and connectors, as well as test probes. <https://www.mill-max.com/pr663>

Mill-Max Mfg. Corp.

Free Info at <http://info.hotims.com/61061-740>



AVIONICS PANEL METER

The Otek APM is a multi-color LED indicator for aircraft that accepts standard 5-32 VDC plus other low voltage/current options. "Powerless" design permits self-powering with only 5 VDC loop burden. Unit can be custom scaled and fits a standard 1" hole. Night-vision compliant and mil-spec approved. The APM replaces NSN: 6620-00-083-8811 for Form & Fit. Also RTCA-160F qualified. For more information: http://otekcorp.com/sites/default/files/apm_1.pdf

Otek Corporation

Free Info at <http://info.hotims.com/61061-741>



New Products

The following companies will be exhibiting at AUVSI's XPONENTIAL 2016 at the Ernest N. Morial Convention Center in New Orleans, LA, May 2 - 5, 2016.

Gimbal Optimized Torque Motors

ThinGap (Ventura, CA) offers highly efficient motors and generators that directly integrate with your system to save space, weight and parts count. Thingap's latest release consists of a suite of gimbal optimized motors designed specifically for low speed precision-slewing and tracking. With high torque-to-mass, zero cogging, and a large clear aperture, they are well-suited for airborne optical systems.

ThinGap's gimbal motor technology includes: industry leading torque to-weight ratios; large clear apertures; brushless DC or synchronous AC operation; and excellent velocity smoothness with True-Zero™ Zero Cogging Torque.



ThinGap motors have high rotor pole counts, larger diameters, and superior cooling relative

to their conventional brushless DC motor (BLDC) counterparts. These features result in a variety of BLDC ring motor options with power-to-weight and torque-to-weight ratios exceeding those of a comparable power conventional BLDC motor.

Booth # 629

For Free Info Visit <http://info.hotims.com/61061-520>

Wireless Transmission System

Persistent Systems, LLC (New York, NY) is introducing the MPU5 — a Smart Radio System that provides both H.264 encoding of HD video and long range reliable transmission on a private and secure network. The MPU5's 3x3 MIMO radio system with up to 6W of transmit power enables it to achieve extremely long range and 100+ Mbps of throughput in complex, urban, high multi-path environments.

The MPU5 has a 3G-SDI input and can encode and stream HD video up to 1080p30 or 720p60 utilizing H.264 in an MPEG-TS stream via UDP or RTP with both Unicast and Multicast support. The MPU5 also has a 10/100 Ethernet port and can be directly connected to cameras that provide their own encoding and streaming functionality. The MPU5 is camera-mountable and includes a 12-hour battery for a full day of continuous operation. In addition, the MPU5's modular radio architecture enables the user to quickly and easily install RF modules for ISM as well as Licensed frequency bands.

Booth # 1547

For Free Info Visit <http://info.hotims.com/61061-521>



Rugged Mission Computer

Elma Electronic Inc. (Fremont, CA) now offers the StorSys-3000, a high-capacity Network Attached Storage (NAS) mission system that withstands harsh, rugged environments for use in IP-based military and defense applications. The reliable



3U VPX computer includes dual 10 GbE ports that feature integrated TCP/IP off-load engines. This frees up the Core i7 processor enabling critical resources to be directed to mission compute tasks, while obtaining optimal link speeds on each input port. These ports, as well as additional I/O such as a VGA, two USB

2.0, three GPIO and an additional two GbE ports, are utilized via MIL-C-38999 connectors on the front end.

A four slot storage array supports over 8 TB of solid state MLC storage with RAID protection and high-speed data access speeds of 1.2 GB/sec. The Intel Gen 3 Core i7 CPU clocks in at 2.5 GHz with unwavering performance to ensure successful data transfer. Designed for use in extended temperature ranges from -40°C to +75°C, the new system incorporates fanless, conduction cooling and a high CFM front-to-back air flow for added heat dissipation. An IP65 rating and high ingress protection ensures internal and external system reliability.

Booth # 1342

For Free Info Visit <http://info.hotims.com/61061-523>

3U VPX Board

Kontron (Poway, CA) is shipping its high performance 3U VPX board, based on the advanced 8-core version of the Intel® Xeon® Processor D architecture (Broadwell DE). The Kontron VX3058 provides two 10 GBASE-KR ports and 8 lanes Gen3 PCI Express to the backplane. Providing more capabilities in a 3U footprint, the VX3058 also offers versatile mezzanine options for XMC, storage, graphics, M.2, and I/O. The M.2 interface can be used for storage or for integration of customized personality modules. Front I/O module options are selectable for DVI/HDMI, Ethernet or other interfaces.



The Kontron VxFabric™ provides a unique API that extends the TCP/IP protocol over the PCI Express infrastructure that, when combined with Kontron's advanced switch technologies, enables significantly higher I/O bandwidth. The Kontron VX3058 is pin compatible with the company's popular and previous generation VX3044 3U VPX board, which already deploys 10 gigabit (G) Ethernet and PCIe gen3 on the OpenVPX backplane. Options include a shelf manager for centralized health management, sequenced system power-up and Temperature/Power/Performance management as well as Power-On Built-in Test (PBIT) that give designers a comprehensive package for board and system diagnosis.

Booth # 779

For Free Info Visit <http://info.hotims.com/61061-531>



High Speed HD Infrared Camera

FLIR Systems (Meer, Belgium) has announced a new addition to its RS-Series of long-range infrared camera systems designed for range tracking, target signature, research, and scientific applications. The new FLIR RS8300 couples a proprietary high-speed HD MWIR detector with a 10x continuous zoom lens in a sealed, ruggedized enclosure. The FLIR RS8300 delivers megapixel infrared imagery at up to 200 megapixels per second. To capture the most fleeting of events the camera is capable of fast frame rates from full-frame resolution 14-bit data at 125 fps to 64×64 at 2 kHz.



Optimized imaging is ensured using the FLIR RS8300 four active preset operating modes to provide adjustable integration times, embedded non-uniformity correction, bad pixel replacement and window size adjustments. The 10x continuous optical zoom lens embeds the focus and focal length information, along with IRIG-B time stamp in every frame of data, allowing for TSPI work.

Booth # 1429, 1431

For Free Info Visit <http://info.hotims.com/61061-525>

Rugged Zero Client

Chassis Plans (San Diego, CA) has released a new patent pending CPZ-156T Rugged Zero Client in partnership with Dell OEM Solutions. The rugged CPZ-156T Zero Client incorporates a Dell PCoIP™ ASIC controller in a robust and rugged enclosure designed to support the warfighter in the harshest conditions. The CPZ-156T includes a 15.6 LCD and 10-point multi-touch screen. The unit conforms to PCoIP™ using the Teradici TERA2321 controller. Power is provided by Power over Ethernet (PoE) for single-cable operation.



The CPZ-156T Rugged Zero Client follows the Army "Approved Thin Client/Zero Client Computing Reference Architecture v1" dated 14 March 2013 which is to be used for SIPRNet and NiPRNet implementations. As such, the CPZ-156T is impervious to malware, virus and other cyber-attack vectors and offers the highest levels of security. The unit is designed to be state of the art in security as there is only one connection to the device and the unit is tethered with no Wi-Fi or Bluetooth to compromise security.

Booth # 1206

For Free Info Visit <http://info.hotims.com/61061-526>



When lives hang in the balance, nothing protects like Parylene.

SCS Parylene conformal coatings can be applied to virtually any surface material to create an ultra-thin, pinhole-free barrier for sensors, MEMS, circuit boards, COTS, power supplies and multi-layer chip packages. SCS Parylene HT® offers superior moisture, chemical and dielectric barrier protection, as well as thermal stability (up to 450°C), higher than most industry-standard conformal coatings. SCS Parylenes also meet MIL-I-46508C and have been shown to mitigate metallic whisker growth.

Specialty Coating Systems is the world leader in Parylene coatings, with 45 years of military and aerospace expertise. Contact SCS today for more information about our innovative solutions for your advanced technologies.

World Headquarters (US): 317.244.1200
www.scscoatings.com/military





AFT Cooled 3U VPX System

Curtiss-Wright's Defense Solutions division (Ashburn, VA) is supporting the new VITA 48.8 Air Flow Through (AFT) cooling standard with a range of 3U and 6U modules designed to bring advanced cooling technology to rugged deployed embedded systems. They recently demonstrated the industry's first functioning AFT chassis based on commercial-off-the-shelf (COTS) 3U VPX modules. The demo featured a 3D printed plastic chassis integrated with Curtiss-Wright's VPX3-1258 single board computer (SBC) and VPX3-716 graphics modules, both outfitted with AFT frames.



Curtiss-Wright has already delivered the industry's first COTS 3U AFT cards and plans to develop a complete range of 3U and 6U AFT products. The first modules slated for use in VITA 48.8 AFT systems are Curtiss-Wright's VPX3-652, VPX3-1259, and VPX3-1258 SBCs and the VPX3-716 graphics module.

Booth # 873

For Free Info Visit <http://info.hotims.com/61061-527>

Unmanned Vehicle Engines

3W International (Bad Homburg, Germany) is introducing an expanded range of engines at XPONENTIAL 2016. Besides the previously exhibited Heavy Fuel (HF) engines, the German engine manufacturer will also exhibit a portion of its petrol engines as well as a complete engine unit. In addition to the engines, the PowerVision GmbH Company uses an RPAS helicopter to show that 3W International's engines can be used in more than just fixed-wing aircraft.



All engines from 3 HP to over 60 HP can be provided with both carburetor and alternatively with electronic fuel injection. Fuel consumption can thereby be reduced due to more exact consideration of all of the operating parameters. The power density can be increased through better mixture treatment and the engine's regulation can be better controlled at various engine powers. 3W International is also introducing engines for hybrid applications in addition to the complete drive units.

Booth # 567

For Free Info Visit <http://info.hotims.com/61061-530>



thin gapTM

High Performance UAV Solutions

Precision Gimbal Motors

Optimized for smooth, stable, low speed torque

Ideal for high end tracking and pointing systems, Thingap precision zero cogging gimbal motors offer the ultimate in silky smooth torque. Thingap designs feature very large clear apertures and industry leading torque to mass ratios. Choose from off the shelf diameters ranging from 1.6" - 7" and a selection of adjustable windings. Still not what you're looking for? Customs are available in a short lead time.



Integrated Starter - Generators

High starting torque, efficient power generation

Ideal for high end tracking and pointing systems, Thingap precision zero cogging gimbal motors offer the ultimate in silky smooth torque. Thingap designs feature very large clear apertures and industry leading torque to mass ratios. Choose from off the shelf diameters ranging from 1.6" - 7" and a selection of adjustable windings. Still not what you're looking for? Customs are available in a short lead time.



Lightweight Propulsion Motors

Industry leading power to weight

When the application requires high power without the bulk and mass of traditional solutions, it's time to talk to a Thingap Engineer. Thingap's lightweight propulsion motor technology has the highest power to weight in the industry and can be found in 100W medical devices to 100kW UAVS to 600kW subsea thrusters. When you need more power in less space... Think Thingap.



 thin gapTM | Innovation in MotorsTM

www.ThinGap.com

(805) 477-9741

NEED TO TRAIN YOUR WHOLE TEAM?

Bring SAE education and training to your location. Get variety, customization, quality and convenience. SAE International Corporate Learning advisors work with you to determine the best options to meet YOUR specific training challenge AND develop solutions to fit your budget and your schedule.

Through SAE Corporate Learning Solutions you can:

- Select a SAE course for delivery at your site
- Purchase a corporate subscription for a few courses or the entire library of over 50 online courses (350+ hours of content available)

Contact SAE Corporate Learning Solutions today to discuss how SAE can best meet your training needs.

training.sae.org/corplearning

SAE INTERNATIONAL CORPORATE LEARNING SOLUTIONS

training.sae.org/corplearning

Contact SAE Corporate Learning:

+1.724.772.8529 or corplearn@sae.org



Ad Index

For free product literature, enter advertisers' reader service numbers at www.techbriefs.com/rs, or visit the Web site beneath their ad in this issue.

Company	Reader Service Number	Page
Abbott Technologies, Inc.	713	17
ACCES I/O Products	720	30
AIM GmbH	728	40
American Institute of Aeronautics and Astronautics	718	27
Aurora Bearing Co.	734	44
Bal Seal Engineering Co.	711	14
C.R. Onsrud, Inc.	717	25
CGI, Inc.	735	45
Collcraft CPS	710	13
COMSOL, Inc.	738, 743	47, COV IV
Cornell Dubilier	716	23
Create The Future Design Contest		29
CST of America, Inc.	742	COV III
Dawn VME Products	723	34
Gage Bilt Inc.	737	46
Heatron, Inc.	725	36
Hunter Products, Inc.	729	40
Imagineering, Inc.	702	1
Kontron America	715	21
LEMO U.S.A., Inc.	719	28
Lyons Tool & Die Co.	732	43
Magnetic Component Engineering, Inc.	708	9
Master Bond Inc.	733, 739	44, 47
maxon precision motors, inc.	730	41
Mill-Max Mfg. Corp	740	47
New England Wire Technologies	705	5
OFS	736	46
OTEK Corporation	741	47
Photofabrication Engineering Inc. - PEI	701	COV II
Photon Engineering	724	35
Proto Labs, Inc.	706	7
PTI Engineered Plastics, Inc.	709	11
Remcom	712	15
Renishaw Inc.	722	33
Rohde & Schwarz	721	31
SAE International	838	51
Servometer	731	42
Specialty Coating Systems, Inc.	836	49
TE Connectivity	703	2
ThinGap Motor Technologies	837	50
Tube Hollows International	707	9
Ulbrich Stainless Steels & Special Metals, Inc.	726	37
Verisurf Software Inc.	727	39
W.L. Gore & Associates	704	3
WinSystems Inc.	714	19

Aerospace & Defense Technology, ISSN - pending, USPS - Application to Mail at Periodicals Postage Prices is Pending at New York, NY and additional office. copyright © 2016 in U.S. is published monthly in February, April, May, June, August, October, and December (7 issues) by Tech Briefs Media Group, an SAE International Company, 261 Fifth Avenue, Suite 1901, New York, NY 10016. The copyright information does not include the (U.S. rights to) individual tech briefs that are supplied by NASA. Editorial, sales, production, and circulation offices at 261 Fifth Avenue, Suite 1901, New York, NY 10016. Subscription is free to qualified subscribers and Subscriptions for non-qualified subscribers in the U.S. and Puerto Rico, \$75.00 for 1 year. Digital Edition: \$24.00 for 1 year. Single copies \$6.25. Foreign subscriptions one-year U.S. Funds \$195.00. Remit by check, draft, postal, express orders or VISA, MasterCard, and American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to *NASA Tech Briefs*, 261 Fifth Avenue, Suite 1901, New York, NY, 10016

POSTMASTER: Send address changes and cancellations to NASA Tech Briefs, P.O. Box 47857, Plymouth, MN 55447.

May 2016, Volume 1, Number 3

Publisher	Joseph T. Pramberger
Editorial Director - TBMG	Linda L. Bell
Editorial Director - SAE	William Vinsic
Editor	Bruce A. Bennett
Associate Editor	Billy Hurley
Managing Editor, Tech Briefs TV	Kendra Smith
Associate Editor	Ryan Gehm
Production Manager	Adam Santiago
Assistant Production Manager	Kevin Coltrinar
Creative Director	Lois Erlacher
Senior Designer	Ayinde Frederick
Global Field Sales Manager	Marcie L. Hineman
Marketing Director	Debra Rothwell
Marketing Communications Manager	Monica Bond
Digital Marketing Coordinator	Kaitlyn Sommer
Audience Development Director	Marilyn Samuelson
Audience Development Coordinator	Stacey Nelson
Subscription Changes/Cancellations	nasa@omeda.com

TECH BRIEFS MEDIA GROUP, AN SAE INTERNATIONAL COMPANY

261 Fifth Avenue, Suite 1901, New York, NY 10016
(212) 490-3999 FAX (646) 829-0800

Chief Executive Officer	Domenic A. Mucchetti
Executive Vice-President	Luke Schnirring
Technology Director	Oliver Rockwell
Systems Administrator	Vlad Gladoun
Web Developer	Karina Carter
Digital Media Manager	Peter Bonavita
Digital Media Assistants	Keith McKellar, Peter Weiland, Anel Guerrero, Maria Sevilla
Digital Media Audience Coordinator	Jamil Barrett
Credit/Collection	Felecia Lahey
Accounting/Human Resources Manager	Sylvia Bonilla
Office Manager	Alfredo Vasquez
Receptionist	Elizabeth Brache-Torres

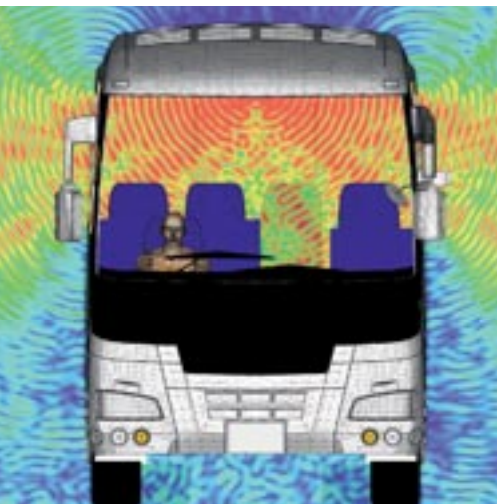
ADVERTISING ACCOUNT EXECUTIVES

MA, NH, ME, VT, RI, Eastern Canada	Ed Marecki
	Tatiana Marshall
	(401) 351-0274
CT	Stan Greenfield
	(203) 938-2418
NJ, PA, DE	John Murray
	(973) 409-4685
Southeast, TX	Ray Tompkins
	(281) 313-1004
NY, OH	Ryan Beckman
	(973) 409-4687
MI, IN, WI	Chris Kennedy
	(847) 498-4520 ext. 3008
MN, ND, SD, IL, KY, MO, KS, IA, NE, Central Canada	Bob Casey
	(847) 223-5225
Northwest, N. Calif., Western Canada	Craig Pitcher
	(408) 778-0300
CO, UT, MT, WY, ID, NM	Tim Powers
	(973) 409-4762
S. Calif., AZ, NV	Tom Boris
	(949) 715-7779
Europe - Central & Eastern	Sven Anacker
	49-202-27169-11
	Joseph Heeg
	49-621-841-5702
Europe - Western	Chris Shaw
	44-1270-522130
Integrated Media Consultants	Patrick Harvey
	(973) 409-4686
	Angelo Danza
	(973) 874-0271
	Scott Williams
	(973) 545-2464
	Rick Rosenberg
	(973) 545-2565
	Todd Holtz
	(973) 545-2566
Reprints	Jill Kaletha
	(866) 879-9144, x168



Make the Connection

Find the simple way through complex
EM systems with CST STUDIO SUITE



Components don't exist in electromagnetic isolation. They influence their neighbors' performance. They are affected by the enclosure or structure around them. They are susceptible to outside influences. With System Assembly and Modeling, CST STUDIO SUITE helps optimize component and system performance.

Involved in antenna development? You can read about how CST technology is used to simulate antenna performance at www.cst.com/antenna.

If you're more interested in filters, couplers, planar and multilayer structures, we've a wide variety of worked application examples live on our website at www.cst.com/apps.

Get the big picture of what's really going on. Ensure your product and components perform in the toughest of environments.

**Choose CST STUDIO SUITE –
Complete Technology for 3D EM.**



CST – COMPUTER SIMULATION TECHNOLOGY | www.cst.com | info@cst.com

Free Info at <http://info.hotims.com/61061-742>



Cov

ToC



MULTIPHYSICS FOR EVERYONE

The evolution of computational tools for numerical simulation of physics-based systems has reached a major milestone.

Custom applications are now being developed by simulation specialists using the Application Builder in COMSOL Multiphysics®.

With a local installation of COMSOL Server™, applications can be deployed within an entire organization and accessed worldwide.

Make your organization truly benefit from the power of analysis.

comsol.com/application-builder



© Copyright 2016 COMSOL. COMSOL, COMSOL Multiphysics, Capture the Concept, COMSOL Desktop, COMSOL Server, LiveLink, and Simulation for Everyone are either registered trademarks or trademarks of COMSOL AB. All other trademarks are the property of their respective owners, and COMSOL AB and its subsidiaries and products are not affiliated with, endorsed by, sponsored by, or supported by those trademark owners. For a list of such trademark owners, see www.comsol.com/trademarks

Free Info at <http://info.hotims.com/61061-743>



Cov

ToC