POSTER PRESENTATIONS

Toward Aerial Grasping Using a Jamming Gripper

Mr. Raymond VonWahlde and Mr. Chad C. Kessens, ARL and CDT Kevin Chen and
CDT Charles Christianson, USMA

While aerial vehicles can access much greater volumes of space than ground-based systems, they traditionally cannot manipulate tools or objects to perform useful work on the environment. Such ability could greatly expand the types of tasks that could be performed robotically, thus providing increased human safety. However, achieving robust grasping for a wide range of object shapes and sizes is challenging for a payload limited, stability-sensitive platform such as a UAV. In this paper, we describe the design and manufacture of a compliant jamming gripper for use on a UAV. We then analyze the gripper's performance over a range of varying object feature shapes and sizes. Ultimately, we show that such a gripper is a good candidate for aerial grasping due to its versatility, compliance, and ease of operation.

KEYWORDS: Jamming, Robot, Aerial, Grasping, Manipulation

CONTACT: Mr. Raymond VonWahlde, RDRL-VTA Bldg 1120B, APG, MD 21005
Email: raymond.vonwahlde.civ@mail.mil TEL: 410-278-9738

Triple Doppler Wind Lidar Observations of Turbulent Winds over Mountainous Terrain

Dr. Christopher Hocut and Dr, Yansen Wang, ARL, Dr. Joe Fernando, Notre Dame, and Dr. Sebastian Hoch, U of Utah

Coordinated triple Doppler wind lidars were used to observe the turbulent winds in the atmospheric boundary layer over mountainous terrain during the **M**ount**a**in **Ter**rain Atmosp**h**eric M**o**deling and Obse**r**vatio**n**s Program (MATERHORN) field campaigns. We first tested the feasibility of the method, by staring the three wind lidars at a specific sonic anemometer situated at the top of a meteorological tower. This allowed a comparison between the time series of the sonic anemometer observed wind components along the Doppler wind lidar beam directions and the corresponding lidar radial wind velocities near the sonic location. Spectral analysis was also performed and the combined results indicated that staring triple Doppler wind lidars at spatial points is a viable technique for observing the large, energetic turbulent eddies within the atmospheric boundary layer where sonic anemometers are very hard or impossible to set up. Secondly, we used coordinated scanning triple Doppler wind lidars to observe the three-dimensional wind field over the mountainous terrain without any flow assumptions, as required with a single or dual lidar retrieval. The comparisons between the wind vectors from the scanning triple lidars and sonic anemometer data from a meteorological tower were satisfactory, however the data points were very scant and a large amount of data were wasted due to difficulties in temporal and spatial synchronization amongst the three lidars.

KEYWORDS: Doppler wind lidar, Atmospheric boundary layer over mountainous terrain

CONTACT: Dr. Christopher Hocut, ARL (ORAU), Adelphi, MD 20783
Email: chocut@nd.edu TEL: 574-631-8129

Development of Military Microgrid Test Bed at ARL

CDT Dylan Smith, Dr. Aaron St. Leger, and CPT Jeremy Spruce, USMA

The fully burdened cost of diesel fuel and risks associated with fuel convoys has led to an increased concern for power system efficiency in deployed environments. Reducing generator use, increasing generator efficiency, and integrating dissimilar energy sources into the power systems of Forward Operating Bases (FOBs) are the primary factors for minimizing diesel fuel usage. Tactical military microgrids combine hybrid power sources, new technologies for power distribution and power control, and alternate system layouts to achieve this objective. The ARL test bed ties a simulated solar photovoltaic source to a power system consisting of a 3-phase power supply, power distribution unit (PDU), intelligent power controllers (IPC), and programmable loads with the intent to develop control and contingency operations on a single network. Multiple tests have been conducted to determine the current controllability of the IPC and PDU on the network, as well as to test the power-supply capability in controlling each phase of power at the PDU. The ARL test bed allows for fully programmable hardware in the loop simulation and testing for small and medium size operating bases. Future research includes developing control algorithms to minimize fuel consumption based on current mission and availability of energy resources.

KEYWORDS: Smart-Grid, Power, Energy

CONTACT: CPT Jeremy Spruce, MSE, USMA, West Point, NY 10996
Email: Jeremy.Spruce@usma.edu TEL: 845-938-5607

Ground-to-air tracking and classification

Dr. David Tahmoush, ARL

An approach for ground-to-air tracking using motion features was developed to provide near real-time adjustments for continuous tracking of helicopters in the presence of extreme maneuvers and at multiple ranges. The features are first thresholded into a mask, interpolated, and then tracked within a basic Kalman filter. A fast classifier was also developed to help recognize particular targets of interest and annotate the corresponding tracks. The fast classifier uses the previously calculated motion features and region of interest from the tracker to reduce the computation and the search space, and this is shown to generalize better than a more traditional image-based classification on the same data.

KEYWORDS: Fast Classifier, Extreme Maneuvers

CONTACT: Dr. David Tahmoush, ARL, Adelphi, MD 20783
Email: david.tahmoush@us.army.mil TEL: 301-394-0867

Visible Raman Spectrometry for Detection of Explosive Compounds on Varying Substrates

Dr. Nicholas F. Fell, Jr., ARL/USMA and CDT Charles Cal and CDT Dairen Jean, USMA

Standoff detection of explosives on surfaces at checkpoints is a valuable tool to saving the lives of US military personnel. Raman spectroscopy provides sufficient information to permit identification of unknown materials, but yields an inherently weak signal limiting standoff ranges. UV excitation improves the signal intensity by a factor corresponding to the wavelength ratio raised to the fourth power (a factor of 16 from visible wavelengths to the UV). An open question is what effect the color of paint used on vehicles will have on the ability of Raman spectroscopy to detect and discriminate explosives on vehicle surfaces. While preparing a UV Raman spectroscopy system to investigate this issue in the UV, we conducted a study on the effect of car paints on the ability of visible Raman spectroscopy to detect 2,4-DNT on Ford color standards. The results confirmed our suspicions that visible Raman spectra suffer from significant interference from luminescence generated by a variety of car paint colors. Studies are now underway using UV excitation to determine whether it is a viable alternative to visible Raman spectroscopy.

KEYWORDS: Raman spectroscopy, Explosives Detection, Substrate Effects, Analytical Chemistry

CONTACT: Dr. Nicholas F. Fell, Jr., ARL/PRC, USMA, West Point, NY 10996
E-mail: nick.fell@usma.edu TEL: 845-938-8624

ARL Weapons, Armor, and Materials Research

Steven C. Taulbee, ARL

As the Army's lead agency for weapons, protection, and materials research and with a strong understanding of future Army needs, ARL is well-suited to capitalize in participation at this conference through an interactive demo of relevant technologies. This demo would highlight advanced technologies of interest for Army applications, including structural and vehicle armor technologies, energetic materials, flexible and ultralight armor materials for Soldier protection, and guidance/navigation/control technologies for precision lethality. Specific displays would include samples of transparent and opaque armor for vehicles, lightweight structural components for aircraft, exothermic combustion simulators, samples of flexible and ultralight material for body armor and head protection, and laboratory munitions with g-hardened guidance/navigation/control components.

KEYWORDS: Vehicle armor, ultralight, exothermic combustion

CONTACT: Steven C. Taulbee, ARL, Aberdeen Proving Ground, MD 21005
Email: steven.c.taulbee.civ@mail.mil TEL: 410-306-0664

Design and Synthesis of Caged Neurotransmitters for the Study of the Brain

LTC Richard L. Comitz and CDT Ryan Zimmerman, USMA

To study the processes involved in many neurological diseases and to better understand the neural network, it is necessary to mimic quantal release of neurotransmitters at specific synapses. To mimic these releases, caged neurotransmitters can be delivered to the desired site of study in brain slices. Caged neurotransmitters are light-sensitive probes that make a neurotransmitter biologically inactive. When irradiated, the neurotransmitter becomes uncaged releasing the bioactive neurotransmitter, which can take part in a biological process. The goal of this research is to synthesize novel caged neurotransmitters with improved qualities and test their efficacy. With the knowledge gained from designing and synthesizing novel caged molecules, other molecules can be caged and used to solve other problems.

KEYWORDS: Caged Neurotransmitter, photolysis, photocage, cage

CONTACT: LTC Richard L. Comitz, CLS, USMA, West Point, NY 10996
Email: Richard.comitz@usma.edu TEL: 845-938-3909

Galleria mellonella: An Innate Immune Response Model for Bacterial Infections

CDT Joseph C. Broderick, USMA

Mammalian infection studies are costly, time consuming and contentions in the realm of ethics. A cheaper, faster and equally as reliable model developed in this experiment may be able to give researchers the insight into infections they need while at the same time minimizing the costs associated with mammalian studies. *Galleria mellonella*, also known as the wax worm, have an innate immune response system similar to those of mammals. The focus of this experiment is on characterizing the innate immune response system of *Galleria mellonella* in response to the multi-drug resistant bacteria known as *Shigella.* Over the course of an infection, prophenyloxidase, an enzyme involved in the melanization process of the immune response, was quantified in infected worms in order to determine the length and severity of the immune response. Hemocytes, the "white blood cells" of the worms, were counted to also track changes in the immune response over a period of time. Preliminary results indicate that prophenyloxidase activity increases with time post infection and then around 18 to 24 hours post infection, activity either normalizes if the *Shigella* strain is not virulent, or drops sharply if it is virulent. Hemocyte numbers follow a similar trend. Outside of potential trends, there were no significant results, but the assay techniques were refined and significant results will follow with further experimentation.

KEYWORDS: Galleria mellonella, Shigella, Prophenyloxidase

CONTACT: CDT Joseph Broderick, USMA, West Point, NY 10996
Email: Joseph.Broderick@usma.edu TEL: 410-868-6572

Noise Cancellation using Carbon Nanotube Thin-Film Loudspeakers and Thermoacoustics

CDT Jordan I. Bush, USMA and Dr. Asha Hall, ARL

Replicating noise cancellation using carbon nanotubes (CNTs) against a commercial loudspeaker may be useful in a prototype of a muffler design system. Using thermoacoustics, sound is able to be created when an AC wave is sent to the CNTs. The low heat capacity per unit area of the nanotubes allows heat to be "dumped" into the surrounding medium which then cools, creating oscillations that are acoustic waves. If the sine wave of the CNTs is set to the same amplitude and frequency as the commercial speaker, but is 180° out of phase, both waves should cancel and create no noise. Although a perfect mutation is only created when all condition are ideal, this projects sets out to determine how reliably CNTs can cancel noise.

KEYWORDS: Carbon Nanotubes, Noise Cancellation, Thermoacoustics, Muffler Prototype, Thin-Film

CONTACT: CDT Jordan Bush, USMA, West Point, NY 10996
Email: jordan.bush@usma.edu TEL: 660- 473-2003

Trust, Decision Making, and Influence in Multi-Genre Networks

Jin-Hee Cho, Kevin Chan, Ananthram Swami, and Brian Rivera, ARL

We study how trust can influence decision making and be used to enhance decision making performance in multi-genre networks. We present our current research work in terms of the following three thrusts.

First, we estimate message reliability (using Twitter data for the case study) using two different methods: *machine leaning* and *maximum likelihood*. The machine learning method predicts reliability based on network features such as retweets or credibility manually judged by human cognition. The maximum likelihood method derives the credibility of messages based on corroboration by independent and reliable sources. We compare the two methods, and discuss the inherent tradeoffs. Finally, we discuss how the two methods can be combined to fine-tune the tradeoff in deciding whether the information is true or false.

Second, we examine how to improve intelligent behavior in multi-agent systems by using a trust-based information and decision fusion technique. Our technique fuses multi-dimensional sensor data in context-specific ways using Subjective Logic (SL) on the basis of trustworthiness of information sources. We compare our trust-based information fusion technique to non-trust based technique. We illustrate our methods via an application to convoy operations.

Last, we study the impact of uncertainty or lack of confidence on the propagation of opinions and the formation of consensus or divergence in social networks. Many social and political issues often lead to extreme divergence of opinions; however, very often people hold opinions without a full sense of confidence. We are interested in how uncertain opinions evolve through interactions in a social network. Our study considers two types of agents, informed agents with high confidence (low uncertainty) and uninformed agents with low confidence (high uncertainty), and examines the impact of the numbers of informed vs. uninformed agents on opinion dynamics. In particular, we use the SL approach to model uncertain opinions (i.e., an opinion consisting of belief, disbelief, and uncertainty). We devise two different trust attitudes, *certainty-based trust* and *similarity-based trust*, and study how the opinions are affected by different trust attitudes and how this impacts consensus.

Keywords: Trust, decision making, influence, fusion, social networks, tactical network

Contact: Jin-Hee Cho, US ARL, Adelphi, MD 20783
Email: jin-hee.cho.civ@mail.mil TEL: 301.394.0492

Testing Photovoltaic Cell Performance in Low-Intensity Light Conditions

CDT Samuel K. Hartford, USMA

Emerging data for the performance of various photovoltaic cells in low-intensity light conditions is presented. A light-tight box with an LED array attached to a variable power supply was constructed to conduct the experiment. By varying the power supply, light conditions incident on the tested photovoltaic cell could be controlled. The resulting power output from the tested photovoltaic cell is then measured and energy conversion efficiency is calculated. This work serves to provide greater depth of knowledge on the behavior of photovoltaic cells in low illumination conditions, allowing for a more refined construction of an long-lived isotopic power source.

KEYWORDS: Low-Intensity Light, Photovoltaic Cell Performance, Isotopic Power Source

CONTACT: CDT Samuel K. Hartford, USMA, West Point, NY 10996
Email: samuel.hartford@usma.edu TEL: 321-604-5175

The Relationship between Foot Structure and Running Biomechanics

CDT Willahelm W. Wan and Dr. Becky A. Zifchock, USMA

Lower extremity injuries such as stress fractures are one of the most common lower extremity injuries. In this study, the relationship between different foot structures (the foot length and flexibility) and the running biomechanics (the average ground reaction force, peak vertical ground reaction force, and loading rate) are examined. The data of various foot structures of Cadets of Class of 2017 was collected during basic training. Data of the ground reaction forces and loading rate are collected from cadet volunteers using instrumented treadmill. Each cadet was asked to run for no more than 15 minutes with a comfortable 7 mph pace, unencumbered. A statistical analysis was done on the foot length, flexibility, average ground reaction force, peak vertical ground reaction force, and loading rate data to yield normalization graph of correlations of these variables and a p-value of the correlations. This study will attempt to add to the literature on the relationship between foot structure and biomechanical forces with the hope that it will lead to more researches in factors that can cause lower extremity injuries and ways to prevent injuries.

KEYWORDS: Foot structure; foot flexibility; foot length; biomechanics, ground reaction forces, loading rate, arch study, West Point cadets, running

CONTACT: CDT Willahelm Wan, USMA, West Point, NY 10997
Email: willahelm.wan@usma.edu TEL: 6263760379

Theoretical Characterization of Visual Signatures (Muzzle Flash)

CDT Oliver E. Di Nallo, CDT Gavin M. Chase, Dr. David O. Kashinski, USMA and
Dr. Edward Byrd, ARL

We are investigating the accuracy of theoretical models used to predict the visible, ultraviolet and infrared spectra of product materials ejected from the muzzle of currently fielded systems. Recent advances in solid propellants have made the management of muzzle signature (flash) a principle issue in weapons development. *A priori* prediction of the electromagnetic spectra of formulations will allow researchers to tailor blends that yield desired signatures and determine spectrographic detection ranges. We are currently employing quantum chemistry methods at various levels of sophistication to optimize molecular geometries, compute vibrational frequencies, and determine the optical spectra of specific gas-phase molecules and radicals of interest. Electronic excitations are being computed using Time Dependent Density Functional Theory (TD-DFT), while the optimized geometries and vibrational frequencies are being computed using Density Functional Theory (DFT), Møller-Plessent Second Order Perturbation Theory (MP2), and Hartree-Fock Self Consistent Field (HF-SCF). A comparison of computational results to experimental values found in the literature is used to assess the affect of basis set and functional choice on calculation accuracy. The current status of this work will be presented at the conference.

KEYWORDS: Time Dependent Density Functional Theory, electromagnetic spectra, muzzle flash

CONTACT: CDT Oliver E. Di Nallo, USMA, West Point, NY 10996
Email: Oliver.DiNallo@usma.edu TEL: 215-272-5227

Assessment of the Adaptive Immune Response to Dengue via ELISPOT Assay

CDT Dillon Macky and CDT Chris Husson, USMA and Morgan Becker, Amanda Kong, Heather Friberg, Jeffery Currier, MAJ Richard Jarman, ARL

Developing a vaccine for Dengue has challenged researchers for decades due to the combination of multiple serotypes and lack of long term cross protection immunity. In order to support the development of an effective tetravalent vaccine, the ELISPOT assay was used to determine the secretion of the IFN-γ cytokine in response to different serotypes of viral peptides of Dengue. The Enzyme-Linked Immunospot (ELISPOT) is used to measure the efficacy of the dengue vaccine. The secretion of INF- γ is a method to quantify the immune response to different peptides of Dengue because after the T-Cells have been washed away the blue imprint of where they secreted INF-γ remains in microscopic dots in the bottom of the 96 well plate. Analysis sheds light on future possibilities of vaccines that can be developed to provide cross protection immunity and drastically limit the impact of Dengue.

KEYWORDS: Dengue Fever, IFN-γ, ELISPOT, cross protection immunity, serotype, T-cells

CONTACT: MAJ Ford M. Lannan, USMA, West Point, NY 10996
Email: Ford.Lannan@usma.edu TEL: 845-938-4378
CDT Christopher Husson, USMA, West Point, NY 10996
Email: Christopher.husson@usma.edu TEL: 719-360-6873

A Study of the Effects of DSSN+ on Preferential Biosorption in Shewanella Oneidensis

CDT Matthew R. Bryan, USMA and Dr. James Sumner and Dr. Justin Jahnke, ARL

Microbial fuel cells (MFCs) offer unique possibilities to remediate waste and produce power. Microbes, such as Shewanella oneidensis, provide an opportunity for alternative energy production from a wide range of potential food sources. However, power density in MFCs is limited by electron transport from the organism to the anode. The use of electron mediators, such as DSSN+, has been proposed to enhance electron transfer and increase power density. To better understand the effects of DSSN+ on the cell membrane of Shewanella Oneidensis, experiments were conducted using functionalized Au nanoparticles. Shewanella cells were treated with various concentrations of DSSN+ and Au nanoparticles were added. This work suggests that treating Shewanella Oneidensis with DSSN+ affects the preferential biosorption of Au nanoparticles in Shewanella Oneidensis.

KEYWORDS: Preferential biosorption, Shewanella Oneidensis, DSSN+

CONTACT: CDT Matthew R. Bryan, USMA, West Point, NY 10996
Email: matthew.bryan@usma.edu TEL: 609-367-5549

Utilizing Solar Energy to Reduce the Weight Soldiers Carry

CDT Nicholas DiVito, USMA and Dr. Stephen Wilkerson, ARL

The average rifleman in an infantry platoon is currently carrying over 96 pounds. Reducing this weight will increase stamina and combat readiness as well as reduce the number of injuries caused by carrying excessive weight. The goal of this research is to look at the feasibility of utilizing solar energy to recharge batteries instead of having soldiers carry extra disposable batteries. To measure the amount of energy the Soldier Wearable Integrated Power Equipment System (SWIPES) can produce, a small solar panel collected data which can be scaled up to the size of the SWIPES system. Soldiers on a 72 hour mission require approximately 9.16 watts of power. The 36cm x 24cm solar panel used in this experiment will not produce enough energy for a soldier but when using the large SWIPES solar panels; the sun can power the mission on a sunny day. However on a cloudy day the amount of energy captured is not enough and on a day in which the sun never comes out, the amount of energy received is almost nonexistent. Therefore, on days with poor weather, solar energy is not a viable option and therefore needs to be used in conjunction with the batteries currently in use. Some considerations include that this experiment was done during the summer when the days are long and the sun is strong. Also soldiers may be wearing the system and therefore will not have the solar panel parallel to the ground. If the weather is poor (cloudy) the solar panel will not produce the maximum amount of energy. Finally the latitude of the operation will affect the amount of energy collected.

KEYWORDS: SWIPES, Solar Energy, Soldier Energy Usage

CONTACT: CDT Nicholas DiVito, USMA, West Point, NY 10996
Email: nicholas.divito@usma.edu TEL: 856-236-9194

Fundamental Mechanisms of Bio-Mediated Nanocluster Synthesis

CDT Alexi Bell, USMA and Dr. Mark Griep, ARL

Tiny noble metal nanoclusters (NCs) fluoresce when they are excited, making them especially useful for bioimaging purposes. Proteins act as biocompatible stabilizing scaffolds of relatively unstable gold nanoclusters (AuNCs). In this study, AuNCs were synthesized using bovine serum albumin (BSA), lysozyme, pepsin, and deribonuclease (DNase1) as capping ligands. The proteins were then characterized spectroscopically. Knowing information about the primary and secondary structures of each protein, the purpose of the research was to determine which structures and properties of a protein are best suited to stabilizing AuNCs while maintaining a high level of fluorescence. Preliminary spectroscopy results reveal that BSA and lysoszyme behave similarly, increasing in luminescence with increasing gold concentration and peaking in their emission spectrums at 5mM Au. Pepsin and DNase1, on the other hand, achieve their peak fluorescence at a concentration of 2.5mM Au.

KEY WORDS: Gold Nanoclusters, Stabilizing Protein Scaffolds, BSA, Lysozyme, Pepsin, DNase1

CONTACT: CDT Alexi Bell, USMA, West Point, New York 10996
Email: Alexandra.bel@usma.edu TEL: 512-574-0580
Dr. Mark Griep, WMD, ARL, APG, MD 21005
Email: mark.h.griep.civ@mail.mil TEL: 410-306-0723

The Layered Terrain Format (LTF)

Julio de la Cruz, RDECOM and Mr. Gregory Peele, ARA

The Layered Terrain Format (LTF) provides a very compact yet rich representation of synthetic environment data designed for efficient environment data interchange. Compared to traditional GIS formats, it is much more flexible yet requires less storage. LTF can represent a superset of vector features, gridded products, triangle mesh products, color imagery, constructive solid geometry, and more, with full attribution and relationships between content elements. LTF can store this wide range of data types within a unified geospatial structure, taking full advantage of modern compression algorithms such as LZMA and JPEG-2000 to decrease storage requirements by orders of magnitude. Although not restricted to modeling and simulation formats, compared to traditional simulation runtime environment formats such as OneSAF, CTDB, and JCATS, the LTF file format is simpler but considerably more flexible.

KEYWORDS: Agile, dynamic, compact runtime, modeling& simulation Layered, Terrain, Formats, geospatial, GPU, CPU.

CONTACT: Mr. Julio de la Cruz, RDECOM, Orlando, FL 32826
Email: julio.a.delacruz4.civ@mail.mil TEL: 407-384-3733

Anthropometric Vulnerability Modeling for Specific Morphologies

Autumn R. Kulaga, Timothy J. Myers, and Patrick J. Gillich, ARL

In 1989 the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) provided their final report on the 1988 U.S. Army Anthropometric Survey (ANSUR), which comprised 1774 men on active duty in the U.S. Army. In 2009 NSRDEC published the ANSUR II Pilot Study that included 2811 male subjects and included 3D digital scans of each Soldier in addition to their anthropometric measurements. The ANSUR studies primarily target providing quantifiable information to material developers and human engineers to support space claim analysis and personnel equipment design. This information is also very critical to the Army human vulnerability modeling and analysis community in the development of new tools and future capability growth. Specifically, these measurements have been used to define different 3D models representative of the 5th percentile female as well as the 25th, 50th, 75th and 95th percentile male. ARL has mapped these geometries to the Army's human vulnerability model that predicts anatomical injury and biomechanical failure of personnel due to an insult to the body. Analysis can be performed using the created anthropometric human models to compare vulnerable area between discrete percentile representations. This research area is on-going to validate this work and improve the Army's capability to provide and assess material protection to our service members by supporting their unique sizes and shapes.

KEYWORDS: Anthropometric Models, Anthropometry, Vulnerable Area, Body Shape, Morphology, Human Vulnerability Modeling

CONTACT: Patrick Gillich, ARL, APG, MD, 21005
Email: Patrick.j.gillich.civ@mail.mil TEL: 410-278-6332

Ancinetobacter baumannii Assessment of Mutations in Outer Membrane Proteins

Nicholas A. Moran, Christopher M. Husson, Joseph C. Broderick, MAJ Ford M. Lannan MS, and COL Carl C. Brinkley PhD, USMA

Acinetobacter *baumannii* is a multi-drug resistant, gram negative bacterium that effects the immunocompromised. Virulence in A. *baumannii* wildtype strains and mutant strains that have been genetically modified to exclude a particular outer membrane protein differs as a result of outer membrane protein mutations. The virulence factors under observation are biofilm formation, motility, drug resistance, iron transport systems, and lethality. We will be analyzing the effects of outer membrane protein mutants on pathogenicity in an attempt to determine an outer membrane protein causing attenuation to use as a target for drug treatment.

KEYWORDS: Acinetobacter, *baumannii*, biofilm, iron chelator, minimum inhibitory concentration, multi-drug resistant, outer membrane protein

CONTACT: MAJ Ford M. Lannan MS, USMA, West Point, NY 10996
Email: Ford.Lannan@usma.edu TEL: 845-938-4378
COL Carl C. Brinkley, PhD, USMA, West Point, NY 10996
Email: Carl.Brinkley@usma.edu TEL: 845-938-3904

Autonomous Systems/Crew Interface and Control

CDT Max Betten, USMA

On my second AIAD (internship) to Tank Automotive Research and Development Engineering Center (TARDEC) in Warren, Michigan I worked with the Dismounted Soldiers Autonomy Tools (DSAT). The project focused on taking an all-terrain vehicle and equipping it with radios and GPS. The objective is to have an autonomous vehicle that can either follow a soldier or be given coordinates to move to. I worked on testing the software Autonomous Navigation and Virtual Environment Laboratory which allowed the team to conduct tests virtually without having to go to a test site and provided the team with instant feedback on issues with the vehicle and the equipment. The knowledge and experience as a cadet and soldier allowed further contributions to be made to how this equipment should be designed and what might be expected in a combat zone when utilizing this tool.

I came to understand all the different aspects and pieces involved in designing autonomous systems and how beneficial virtual testing and computing power can be. The AIAD not only benefited me as far as academics, but militarily as well. I learned of all the potential technology that could be made available to military officers in the future and the capabilities of the research and development center.

KEYWORDS: Autonomous System, TARDEC, Radios, GPS, Crew Interface, Controls, TACOM, ANVEL, virtual machine, virtual environment, DSAT, GVR

CONTACT: CDT Max E. Betten, USCC, USMA, West Point, NY 10996
Email: max.betten@usma.edu TEL: 732-575-0796

Reaching Consensus by Allowing Moments of Indecision

Adam Svenkeson and Dr. Ananthram Swami, ARL

Group decision-making processes often reduce to a never-ending conflict between two opposing subgroups. Using analytical arguments based on a master equation description of the majority opinion dynamics occurring in a model of cooperatively interacting agents, we show how the capability of a social group to reach consensus can be enhanced when there is an intermediate state for indecisive individuals to pass through. We also study the impact that agents committed to a single opinion have on the formation of consensus among the rest of the group members. We propose a model with multiple intermediate states separating two polar opinions that allows a group to reach consensus using a minimal amount of cooperation.

KEYWORDS: Opinion dynamics, social group, cooperation, consensus, phase transition

CONTACT: Adam Svenkeson, ARL, Aberdeen, MD 21001
Email: adam.j.svenkeson.ctr@mail.mil TEL: 410-278-8944

Hierarchical Assembly of DNA Bio-Templated Nano-wire and Nano-tube Films for Lightweight Multi-functional Materials

LTC John F. Burpo, MAJ Stephen J. Winter, CDT Benjamin E. Barclay, CDT David M. Brown, CDT Shawn P. Cooper, CDT Connor H. Mulhere, and CDT Alex Parra, USMA

DNA hydrogels can serve as 3-dimensional bio-templates for tunable nano-porous materials that serve both as electrochemical power sources and structural material. We present a general approach to 1) form a DNA hydrogel; 2) sensitize the DNA bio-template using catalytic palladium ions to mediate the electroless deposition; 3) synthesize 3-dimensional networks of copper and nickel nano-wire films via electroless deposition; 4) synthesize inorganic salt templated square cross-section nano-tubes that can be integrated into a hierarchal nano-material assembly. Such multi-functional electro-mechanical materials are envisioned to decrease the systems mass across a broad range of Army platforms and serve as a nano-architecture for other applications such as photovoltaics, catalytic systems, sensors, and energy absorption.

KEYWORDS: DNA hydrogel, bio-templates, nano-materials, electrochemical, biotemplating

CONTACT: MAJ Stephen J. Winter, C&LS, USMA, West Point, NY 10996
Email: stephen.winter@usma.edu TEL: 845-938-4095

Studying Cyber-War through Multi-Agent Cognitive Modeling

Dr. Noam Ben-Asher and Dr. Anathram Swami, ARL and Dr. Cleotilde Gonzalez, Carnegie Mellon University

Cyber-war is a growing form of threat that involves multiple nations executing simultaneously offensive and defensive operations in cyber space. In such hyper dimensional and dynamic environment, agile and adaptive machine-aided human decision making processes are crucial. To unfold the decision making processes that drive the dynamics of cyber-war, we use a multi-agent model comprising of cognitive agents that learn to make decisions according to the Instance-Based Learning Theory (IBLT). In our paradigm, the CyberWar game, assets and power are two key attributes that influence the decisions of agents. Assets represent the key resource that an agent is protecting from attacks while power represents technical prowess of an agent's cyber security. The agents in the game learn from experience to attack other agents and defend themselves in order to maximize their own assets. Importantly, the agents do not learn by using predefined strategies, as many multi-agent models do, but instead they learn from experience according to the situation and actions of others. The results of simulated cyber-wars reveal how power influences the behavior agents adopt overtime. Powerful agents learn to become aggressive in attacking other agents, contrary to agents with low power that become defensive. This study proposes a novel approach to study the dynamics of cyber-war, using cognitive agents in a multi-agent setting that can provide understanding of the decision making processes as well as support for a decision maker in a complex and dynamic environment.

KEYWORDS: Cognitive modeling, cyber-war, multi-agent, cyber security investments, decision making

CONTACT: Dr. Noam Ben-Asher, ARL, Adelphi, MD 20783
Email: nbenash@us.ibm.com TEL: 412-862-5708

The effects of sustained cognitive and physical load on Soldier performance and electrocortial dynamics

Dr. J. Cortney Bradford and Dr. Daniel P. Ferris, U of MI, Dr. Jason S. Metcalfe, DCS Corp., and Dr. Jamie R. Lukos, Dr. Kelvin S. Oie, and Dr. Keith W. Whitaker, ARL

The main purpose of this study is to better understand the physiological and behavioral responses during sustained tasks that are simultaneously physically and cognitively demanding. Understanding the way the body responds and how performance changes during complex physical-cognitive tasks remains unclear, particularly in operationally-relevant conditions. To investigate this, participants perform a physical task (walking while carrying a loaded Army-issue rucksack) while also executing a cognitive task (visual target detection). While performing this dual task, participants are outfitted with a novel combination of recording devices to record brain activity (electroencephalography, EEG), muscle activity (electromyography, EMG), heart rate, temperature, movement biomechanics (acceleration and force production), and task performance. Participants are also periodically sampled for hormonal fluctuations (salivary secretions) and undergo psychological evaluations (questionnaires). With this robust set of data, we will gain unique insights into the behavioral and physiological basis of physical and cognitive interactions, as well as determining which computational techniques are most effective in detecting/predicting changes in Soldier performance. The knowledge resulting from this study could help to develop better monitors of Soldier health and effectiveness, enhance scheduling of tactical deployments, and optimize training regimes. This project is a CaN CTA collaborative effort across ARL, the University of Michigan and DCS Corp. (Alexandria, VA). Data collection is currently underway at the ARL Soldier Performance and Equipment Advanced Research (SPEAR) facility and preliminary data analyses techniques are being tested.

KEYWORDS: Mobile brain imaging, human locomotion, multi-sensor integration computational neuroscience, motor control

CONTACT: J. Cortney Bradford, RDRL-RHS-C (ARL/HRED/TNB), APG, MD 21005
Email: Jessica.bradford3.ctr@mail.mil TEL: 410-278-0463

Information cascades and limited attention in feed-based networks

S. Sreenivasan, G. Korniss, and B. K. Szymanski, RPI and K. S. Chan and A. Swami, ARL

In online social networks, where the actions of users are in response to a newsfeed, the amount of attention devoted by users to distinct items on their respective feeds potentially plays an important role in the ability of information to cascade globally through the network. We study a parsimonious model for information cascades on such attention-limited, feed-based networks, by assuming that users pay attention only to the top L items on their feed. Users generate new items with probability p_n and additionally forward each item on their feed to their neighbors, independently with probability p_r. We define the cascade size associated with an item as the number of users participating in forwarding that item. On scale-free networks, with fixed p_n and L, at low values of p_r, we find that the probability distribution of cascade sizes is a power-law with an exponential cutoff, transitioning to a pure power-law at intermediate values of p_r, with global cascades becoming increasingly prevalent at higher pr values. Similar to classical branching processes, these distributions suggest the existence of a critical value of p_r beyond which global cascades become appreciable in probability. The critical value itself appears to have an inverse dependence on L. We aim to show analytical calculations that support our simulation results, and further present the outcome of the model on networks with community structure. To validate the model, we analyze data collected from Twitter for a set of hashtags over a period of two weeks. This also allows us to calibrate the model parameters (L, p_n, p_r) and use this model to understand various conditions for information cascades.

KEYWORDS: Information Cascades, Limited Attention, Network Science

CONTACT: Kevin S. Chan, ARL, Adelphi, MD 20783
Email: kevin.s.chan.civ@mail.mil TEL:301-394-5640

A Generative Growth Model for Collaboration Structures

Ertugrul Necdet Ciftcioglu, ARL and Prithwish Basu Ram Ramanathan, Raytheon

Many large endeavors in society such as scientific discoveries and the production of motion pictures are a result of collaboration. We investigate the fundamental characteristics of the underlying collaboration structures that exist in several fields such as sciences and movie production. Consider a set of researchers {a, b, c, d} who have co-authored four papers among them (denoted by a hypergraph consisting of four hyperedges: H = {(a, b), (a, b, c), (a), (a, d)}). While these constitute the results (or artifacts) of collaboration, the collaboration relationship itself has only two elements S = (a, b, c), (a, d), since, for example, the (a, b, c) collaboration already captures the (a, b) collaboration. Previous efforts on characterizing models for collaboration have focused on modeling the "artifacts" (basically, the distribution of sizes and degrees of hyperedges, which correspond to papers, movies etc.). However, modeling the underlying structure of collaboration itself is important and cannot be easily learned by examining the distribution of the artifacts.

In this work, we study the basic nature of the underlying collaboration structure using a tool from algebraic topology, namely, the simplicial complex. In general, the facet degree (number of facets that a node belongs to) and hyper-edge degree (number of hyperedges that a node belongs to) have significantly different statistical distributions. Similarly, facet and hyperedge size distributions are also different, especially at the head where significant probability mass is concentrated.

We propose a generative facet growth model GeneSCs based on preferential attachment (PA) that is based not on an individual's node degree but with his/her facet degree – the underlying intuition is that outsiders are more likely to approach collaborators who are part of multiple collaborations, not people who have many collaborators within a single collaboration. Essentially, collaborations arrive into the system as facets which may be isolated, may partially or completely subsume existing collaborations, or may get subsumed by them. GeneSCs takes as input the facet size distribution (which is not necessarily power law), and two parameters c,b fitted for the relation $Ft = cVtb$ for time-evolving pairs (Ft,Vt) of number of facets and number of vertices in the given data. Adapting the master equation approach and also taking facet subsumptions into account, we show that the facet degree distribution of the thus generated simplicial complexes is power-law distributed. We also show using empirical statistical analysis that the facet degree and size distributions of the generated simplicial complex have low Kolmogorov-Smirnov (KS) and Total-Variation (TV) distances from the real data (we used DBLP data for the case study). GeneSCs significantly outperforms the Structural PA model after adapting it to carry out subsumptions.

Other metrics such as distributions of holes and missed collaborations are topics of future research.

KEYWORDS: Collaboration structures, Generative models, Simplicial Complexes, Complex Networks

CONTACT: Ertugrul Necdet Ciftcioglu, Post-Doc ARL/IBM
Email: enciftcioglu@gmail.com TEL: 814-321-5492

Virtual Diffraction Of Multimillion Atom Simulations

Dr. Shawn P. Coleman and Dr. Mark A. Tschopp, ARL

This work outlines a novel virtual diffraction method that bridges between simulation and experimental studies by producing electron and x-ray diffraction patterns directly from atomistic simulation data. Classical atomistic simulations can help to shed light on the underlying structures and mechanism associated with important material properties by explicitly modeling the interactions of multimillion atoms. While traditional methods of analyzing these simulations can provide tremendous insight into material phenomena, these tools are not directly reproducible through experiments and are often not applicable for complex material systems. The new virtual diffraction method mimics well-established electron and x-ray diffraction techniques used to explore the atomic scale structure of materials that determine its proprieties. The virtual diffraction method, implements a highly parallelized algorithm to compute diffraction intensity data across a high resolution, three-dimensional mesh of reciprocal space. Virtual selected area electron diffraction and x-ray diffraction line profiles are then created by appropriately analyzing this three-dimensional intensity data which enables the bridge directly to experimental results. In addition to a description of the technique, current applications of the virtual diffraction method is also discussed.

KEYWORDS: Molecular Dynamics, X-ray Diffraction, Electron Diffraction

CONTACT: Shawn P. Coleman, RDRL-WMM-F; APG, MD 21005
Email: shawn.p.coleman8.ctr@mail.mil TEL: 410-306-0697

Short Range Low-VHF Channel Modeling and Measurements

F. T. Dagefu, G. Verma, C. R. Rao, P. L. Yu and B. M. Sadler, ARL

Achieving a reliable communication link that is not significantly impeded by the presence of obstacles and scatterers is extremely challenging especially in complex propagation environments such as urban canyons, tunnels and indoor environments. The lower VHF band has significant potential to support low complexity, low power, and highly reliable communications among near-ground nodes and is well suited for highly accurate localization solutions, in highly cluttered environments. The large size of conventional antennas has been a major obstacle in terms of developing small robotic platforms (e.g. crawlers and rovers). In collaboration with the University of Michigan, a set of highly miniaturized antennas with good performance have been developed and currently active and tunable antennas with wider bandwidth are being designed. We also investigated the channel characteristics of the lower VHF band via high-fidelity FDTD propagation simulations as well as measurement campaigns using a receiver and miniaturized antenna mounted on a mobile platform to efficiently collect large data sets. The current focus of the work includes performing large-scale EM propagation simulations on HPC platforms for spatial phase analysis and multipath characterization as a function of frequency. We also developing algorithms for RSS and phase based multi-sensor geolocation solutions. We are developing algorithms to analyze a large data set we collected for phase and RSS based localization as well as looking into sensor fusion with robotic motion data.

KEYWORDS: Scatterers, tunable antennas, HPC platforms

CONTACT: Fikadu Dagefu, ARL, Adelphi, MD 20783
Email: fikadu.t.dagefu.ctr@mail.mil TEL: 301-394-0405

Detecting UAS using an information theoretic model of visual attention

Dr. Andre Harrison and Dr. Adrienne Raglin, ARL

A computational model of visual attention based on concepts from information theory is presented. This model makes predictions about which locations in an image are likely to attract a person's attention by estimating the entropy throughout the image. This model also makes predictions based on the motion of objects in the scene by estimating the mutual information from one frame in a video to the next. This computational model of visual attention utilizes parametric models of the statistics of natural scenes, which have been used as solutions in a number of other problems in image analysis, but this model is the first one to use them to predict visual attention. As an early test of the model it is used to detect the motion of UAS in a scene.

KEYWORDS: Visual saliency, attention, natural scene statistics, entropy, unmanned aerial systems, mutual information

CONTACT: Dr. Andre Harrison, ARL, Adelphi, MD 20783
Email: andre.v.harrison2.ctr@mail.mil TEL: 301-394-1775

Magic Squares and Magic Sums

CDT Stephanie Michelle Hetland, Dr. Candice Price, and Dr. Jocelyn Bell, USMA

Magic Squares are historically some of the most studied arrays of numbers. They were discussed in every era from Ancient China to the modern day. In this presentation we present the various properties of a magic square and the results that occur when functions are used to combine and alter the squares.

KEY WORD: Magic Squares, Latin Squares, Magic Sums

CONTACT: CDT Stephanie Hetland, USMA, West Point, NY, 10997
Email: stephanie.hetland@usma.edu Tel: 904-322-1037
Dr. Jocelyn Bell, USMA, West Point, NY 10996
Email: Jocelyn.Bell@usma.edu TEL: 845-938-0690
Dr. Candice Price, USMA, West Point, NY 10996
Email: Candice.Price@usma.edu TEL: 845-938-6728

Reducing Background Noise in Stimulated-Raman Scattering

CDT Taylor Powell, USMA and Dr. Stephen Roberson, ARL

A method for reducing background signal noise in stimulated Raman spectra using a pi-gate phase shift is examined. The use of this method requires a pulse-shaper to both create a transform-limited beam and induce a pi-gate phase shift at chosen wavelengths within the beam. Spectra were obtained for different locations of the pi-gate and a differential measurement is conducted in an attempt to cancel out the background noise that normally hides the Raman spectrum. The purpose of this experiment was to try and validate results obtained by Dr. Hadas Frostig and published in Optics Letters Vol. 36 No. 7. This experiment was unable to replicate the results under any one of several conditions similar to those specified in the paper.

KEYWORDS: Raman Scattering, Pulse Shaper, Background Noise, Raman Spectra

CONTACT: CDT Taylor Powell, USMA, West Point, NY 10996
Email: Taylor.Powell@usma.edu TEL: 757-705-5700

Tracking Antibiotic Action with Hyperspectral Imaging

2LT Jonathan Kaicher , 2LT Michael Gotschall, CDTs Joseph Jude, CDT Katherine Browning, CDT Shena Cousens , CDT Raoul Valencia , CDT Francisco Ramos, CDT Ishmael Raheem, and Dr J. Kenneth Wickiser, USMA and Dr. Nicholas F. Fell, Jr., ARL

This novel use of hyperspectral imaging (HSI) tries to determine whether HSI is effective in detecting cellular responses to antibiotics, if different antibiotics result in different effects on cells, and which ENVI algorithms are most useful in mapping spectral information onto the images taken. The experiment conducted involved growing Ampicillin-resistant E. coli identifiable by a modification allowing them to produce green fluorescent protein, inoculating them with three different antibiotics (Ampicillin, Ciproflaxin, and Streptomycin) and finally using HSI to detect changes in the reflectance spectrum. Using ENVI software, the preliminary results indicate that HSI shows that the three antibiotics produced different cellular responses and that the ENVI algorithms, MTMF and SAM, serve to best analyze and present the data.

KEYWORDS: Hyperspectral imaging, Bacteria, Antibiotic effect, Image analysis

CONTACT: Dr. Nicholas F. Fell, Jr., PRC, USMA, West Point, NY 10996
Email: nick.fell@usma.edu TEL: (845)938-8624

Trust Management for Service-Oriented Mobile Ad Hoc Networks

Yating Wang, Ing-Ray Chen, Jin-Hee Cho, and Ananthram Swami, ARL

We investigate trust management schemes for service-oriented MANETs which should take into account design challenges including lack of centralized authority, high network dynamics, and resource constraints. In addition, MANET environments suffer from high security vulnerabilities due to unreliable wireless transmission and the lack of a centralized mechanism to deal with misbehaving entities. In our work, we consider both attackers' malicious behaviors that seek to disrupt system functionality and agents' selfish behaviors to maximize their own utilities. We present our work in the following three research thrusts.

First, we design a logit regression-based trust model, called *LogitTrust*, to dynamically estimate trust in service providers based on their distinct behavior patterns in response to environmental changes. We demonstrate that *LogitTrust* outperforms traditional Bayesian-based counterparts in trust accuracy and attack resiliency, given the same amount of observations. We also show that *LogitTrust* yields high service success rate with low false positive rate.

Second, we develop a multi-trust-based heuristic algorithm to solve a multi-objective optimization (MOO) problem of dynamic service composition and binding in tactical networks. This work aims to minimize the service cost and to maximize the Quality of Service (QoS) and Quality of Information (QoI). Our proposed algorithm achieves near-optimal solution quality with linear runtime complexity. Further, the experimental results demonstrate that the proposed algorithm outperforms non-trust-based counterpart as well as a single-trust-based algorithm in MOO performance by effectively penalizing malicious nodes.

Last, we devise a trust-based heuristic algorithm based on auctioning to solve a task-assignment problem with multiple objectives. The algorithm has linear runtime complexity, allowing dynamic node-to-task assignment to be performed at runtime. Our result shows that the proposed trust-based algorithm outperforms a non-trust-based counterpart using blacklisting techniques while reaching a near-optimal solution quality with linear runtime complexity.

KEYWORDS: Trust, trust management, reliability, multi-objective optimization, mobile ad hoc networks, malicious behavior

CONTACT: Yating Wang, Virginia Tech, Falls Church, VA 22043
Email: yatingw@vt.edu TEL: 301-394-0492

Panoramic Site Surveillance: Asset Protection Utilizing IR Spectra

CDT Ezra Engel, USMA and Dr. George Thomson, ARL

The goal of this project was to create a 360 degree panoramic detection device for asset protection. Previous research projects have studies the use of high speed panoramic lenses for use in the infrared spectrum with a resulting low quality image. The purpose of this study was to examine the feasability of a cheaper, higher resolution solution utilizing modified commercial products. This study made extensive use of the GoPano© panoramic lens treated for use with the far infrared spectrum. Final experiments yielded positive results with high image quality and positive detection of personel. These preliminary feasability tests with the far IR demonstrate incredible promise for future experiments and setups which utilize the thermal IR.

KEYWORDS: Panoramic, Infrared, AssetProtection

CONTACT: CDT Ezra Engel, PANE, USMA, West Point, NY 10997
Email: ezra.engel@usma.edu TEL: 973-666-1944

A Bed Load Estimate for the Lower Mississippi River

MAJ Richard L Knox, USMA and Dr. Edgardo Latrubesse, U of TX

This study estimates the bed load of the Lower Mississippi River (LMR) below the Old River Control Structure between 2002 and 2011. Since it is not measured at gauging stations, quantifying this sandy sediment has a number of important implications for understanding channel morphology, sediment transportation and distribution, flood control and navigation, sediment diversion to coastal areas, and wetland health. A technique for estimating bed load using time-elapsed, three-dimensional bathymetric images was developed. An ArcGIS routine was developed to conduct cross-correlation in downstream-oriented profiles determining the lag, or average distance bedform crests moved downstream. Microsoft Excel was used to find the average bedform height in each profile. Bed load was estimated using the Exner equation on seven different days in 2010, 2011, and 2012 based on the lag and bedform height taken during surveys conducted at discharges between 5,500 m3s-1 and 45,000 m3s-1. A rating curve was developed and applied to each day of the record estimating that the bed load percent of sand load was 11%. While most of the sand load was found to be in suspension, more work should be done to improve estimate techniques and increase temporal resolution. This method for estimating bed load is an improvement over other two and three-dimensional methods and should be employed in future studies.

KEYWORDS: Lower Mississippi River, Bed Load, Bed forms, Cross-correlation

CONTACT: MAJ Richard L Knox, USMA, West Point, NY10996
Email: Richard.Knox@usma.edu TEL: 845-938-3042

CFD Aerodynamic Characterization of a High Maneuverability Airframe

CDT Craig J. Coyle, USMA and Dr. Sidra I. Silton, ARL

A computational fluid dynamics (CFD) approach to the aerodynamic characterization of a new design for a guided shoulder or artillery fired projectile is presented. The commercial CFD software *CFD++* version 14.1.1 was utilized to apply the Reynolds-Averaged Navier-Stokes equations with the *k*-□-*Rt* turbulence closure model to the airframe. Several canard deflection angles for roll control over multiple angles of attack were investigated. The force and moment coefficients of the projectile as a whole, as well as several of the individual projectile components were determined and plotted as functions of angle of attack and canard deflection angle. Additionally, flow visualizations were created using the analysis software *EnSight* to investigate the flow interactions between the airfoil shaped canards and the flat plate fins located at the base of the projectile. Tip and root vortices produced by the canards and interacting provided a significant area of interest and focus for future work.

KEYWORDS: Computational Fluid Dynamics (CFD), *CFD++*, RANS, Projectile Aerodynamic, Vortex Interactions, High Maneuverability Airframe

CONTACT: CDT Craig J. Coyle, USCC, USMA, West Point, NY 10996
Email: Craig.Coyle@usma.edu TEL: 845-304-2104

Modeling Group Dynamics in Multi-Source Data

Lin Li and Ananthram Swami, ARL

Mathematical modeling and theoretical analysis of the dynamics of a social group is an important problem with diverse applications. In the past two decades, advances in information, communication and data storage have allowed us to collect more data at a faster rate from multiple information sites and over time. These data are often high dimensional embedded in a low-dimensional space and correlated in time. A critical challenge in handling these large amounts of data is how to efficiently harvest them and organize the data into meaningful structures, for example, the similarity between various information sources and the evolution of group structures (i.e., clustering of agents' social activities, customers' buying behaviors, identification of an author's expertise, etc.). We propose a general modeling framework for learning the group dynamics in data collected from multiple information sources and over time. In particular, groups are characterized by specific temporal patterns based on hidden Markov models (HMM). Tensor decomposition techniques combined with graphical models are used to perform inference on the latent variables that describe the relationships between different social groups. The objective is to demonstrate that tensor decomposition can be used to transform graphical models into structurally simpler graphical models that approximate the same joint probability mass function (PMF) and to highlight its usefulness in learning the underlying social structures, making inference and performing predictions.

KEYWORDS: Dimensional embedded, group dynamics, decomposition

CONTACT: Lin Li, ARL, Aberdeen, MD 20051
Email: lin.li7.ctr@mail.mil TEL: 626-378-9925

The Effects of Calcium on the Cell Cycle of the Malaria Parasite *Plasmodium falciparum*

CDT Brittney Murray, CDT Sam Brown, CDT Stephen Chong, CDT Carissa Pekny, and COL Carl Brinkley, USMA

This study assesses the development and growth of *Plasmodium falciparum* and the impact of calcium on its life cycle. This work seeks to discover the effects of varying calcium ion concentrations within the parasites. During these studies, calcium ion concentrations were manipulated and used to treat cultured malaria. The cultures were tested to determine the effects on parasite growth. A second test was conducted to determine the effects of calcium and R568, a calcimimetic, to determine if further testing would impact the rate of infection. R568 is able to allosterically alter calcium-sensing receptors. Cultures were maintained and observed over 72 hours. Data from these studies suggested that calcium treatment increases newly infected red blood cells. We conclude that further testing with calcium and R568 is necessary to investigate the impact of calcium with red blood cell invasion by *P. falciparum*. Future experiments will explore the ideal varying calcium concentrations *in vitro* as well as testing anti-cancer compounds and their effects on cell cycle progression.

KEYWORDS: *Plasmodium falciparum*, calcium, R568, malaria

CONTACT: COL Carl Brinkley, Ph.D., USMA, West Point, NY 10996
Email: Carl.Brinkley@usma.edu TEL: 845-938-3904

Life Cycle Progression in the Malaria Parasite *Plasmodium falciparum* Due to the Combination of Artemisinin and Melatonin

CDT Anthony Cox, CDT Riley Ping-Medvigy, CDT Samuel Brown, CDT Stephen Chong, CDT Joe Jude, and COL Carl Brinkley, USMA

This study, analyzes the development and growth of *Plasmodium falciparum* when paired with Melatonin (a hormone) and Artemisinin (anti-malarial drug). This analysis seeks to discover if melatonin used in combination with artemisinin, will have an enhanced effect on lowering the level of parasetimia within red blood cells. When the malaria parasite is exposed to artemisinin alone, it enters a dormant stage in which the anti-malarial drug, artemisinin, cannot interact with the parasite. Through the introduction of melatonin, the red blood cells are expected to progress beyond this dormant stage back into an active life cycle. The cultures were observed over a 48 hour period, through the use of flow cytometry. Data from this study, suggests that melatonin paired with artemisinin had an increased effect on reducing the number of parasites present. We conclude that further testing is required to statistically verify the effects of these drugs on cells infected with the malaria parasite. Future experiments are to include discovering an ideal concentration combination in vitro as well as testing anti-cancerous compounds and their effects on cell cycle progression.

KEYWORDS: *Plasmodium falciparum*, Artemisinin, Melatonin, Malaria

CONTACT: COL Carl Brinkley, Ph.D., USMA, West Point, NY 10996
Email: Carl.Brinkley@usma.edu TEL: 845-938-3904

Materials Science Under Extreme Conditions at the Army Research Laboratory

Timothy Jenkins, ARL

The study of matter at extreme conditions of pressure and temperature represents a forefront area of research activity across multiple fields of sciences. During the last few years, researchers at the U.S. Army Research Laboratory have been using high-pressure techniques as part of an effort to investigate innovative approaches that will ultimately enable revolutionary advances in lethality capabilities. An overview of the high-pressure facilities and capabilities at the U.S. Army Research Laboratory will be presented and opportunities for collaborative research will be discussed.

KEYWORDS: High-pressure, Extreme Conditions, Lethality

CONTACT: Timothy Jenkins, RDRL-WML-B, ARL, APG, MD 21005
Email: timothy.a.jenkins51.civ@mail.mil TEL: 410-306-1902

Big Data Challenges – Information Overload in Tactical Operations

Debbie Patton and Laura Marusich, ARL

There is a need for systematic investigation of how human decision-making affects and is affected by the rapid increase in communications and information flow brought about by the transition to network-enabled operations (Alberts & Garstka, 2004). The challenges associated with Big Data (volume, variety, velocity and veracity) become relevant for Soldier performance at the Mission Command and squad leader levels. The goal of the presented work is to explore the relationship between these Big Data variables and human cognitive performance, particularly in the military domain. We are conducting an experiment in which we manipulate the amount and rate (volume and velocity) of information presented to participants, and assess the participants' decision-making accuracy and task completion times. One phase of this study focuses on the squad leader and is conducted in ARL's Immersive Cognitive Readiness Simulator (ICoRS) which allows replication of the environment of a squad leader. The second phase focuses on the role of a company commander and simulates the Mission Command environment. We present preliminary results from both phases of study and discuss future work in which participants in each phase of study interact with each other and cooperate to complete a task.

KEYWORDS: Network science, cognition, performance, decision-making, big data, military

CONTACT: Laura Marusich, ARL, APG, MD 21005
Email: laura.r.marusich.ctr@mail.mil TEL: 254-288-9377

UAV Propulsion Systems & Combustion Research

Michael R. Szedlmayer, Ph.D., ARL

The ARL Engines Team has established a new facility for research and testing of UAV propulsion systems at Aberdeen Proving Ground. The facility has a full range of capabilities spanning from computer modeling, to spray combustion visualization, to engine-level dynamometer research, to simulated altitude testing. Our experienced team has been assembled from industry, academia, the Department of Defense, and NASA. By the end of this calendar year, experiments will be brought online to study fuel variability effects in fielded engines, the effects of ambient conditions on internal combustion engines in an altitude chamber, and laser diagnostic measurements on optically accessible engines. Our goal is to use basic and applied research to improve the reliability, thermal efficiency, and performance of UAV propulsion systems. This presentation will focus on our capabilities and our upcoming research plans.

KEYWORDS: Spray Combustion, Ambient Conditions, Altitude Chamber, Laser Diagnostic, UAV Propulsion

CONTACT: Michael T. Szedlmayer, Ph.D., ARL, Aberbeen, MD 21005
Email: michael.t.szedlmayer.ctr@mail.mil TEL: 410-278-9455

Characterization of the Kinetics of a Self-Cleaving DNA Biosensor

J. Kenneth Wickiser, Ph.D., Lara Murcin, and CDT Matthew McClenathan, USMA

A novel biosensor platform was developed in a collaborating laboratory using evolutionary techniques. Our team has used novel optical techniques to characterize the enzymatic behavior of the self-cleaving DNA biosensor. The effort has served as a proof-of-principle demonstrating that a fluorescent dye, SybrGreen®, can be relied on to provide detailed information about the structure of nucleic acids-based sensor and reporter systems. This DNA will serve as a scaffold onto which other sensor domains can be appended thus expanding the suite of robust and efficacious nucleic acid structures available for molecular engineering into nanodevices.

KEYWORDS: DNA, Kinetics, Enzyme, Biosensor, Fluorescence, Chemistry, Detection

CONTACT: Dr. J. Kenneth Wickiser, MADN-CHM-LS, USMA, West Point, NY 10996
Email: john.wickiser@usma.edu TEL: 845-938-5813

A CIP Study of UHPC

CDT Brad Brownfield and CDT Ian Williams, USMA

Ultra high performance concrete is a mixture of Portland cement, silica fume and silica flour, silica sand, water and high-range water-reducing admixture. The proportions of the ingredients are chosen to optimize the hydration process, and particle packing. Typical compressive strengths for UHPC are on the order of those for mild steel. The weak link in the resulting product is the macroscopic voids that remain even though the mixture flows and is consolidated through vibration. The goal of this research was to try to adapt processing technologies for ceramics in a fashion that would reduce the void ratio in the UHPC. Of the three types of pressing used in the production of ceramics, cold-isostatic pressing (CIP) was chosen, primarily because the available equipment for warm- and hot-isostatic pressing utilizes temperatures beyond the range normally used in curing UHPC. Densities and compressive strengths for specimens treated with a variety of pressures will be presented, along with recommendations for future research.

KEYWORDS: Cold-isostatic pressing, ultra high performance concrete, density, ultrasonic mixing, particle-size distribution, particle packing, void space, microscopy

CONTACT: DR Chris Conley, DCME, USMA, West Point, NY 10996
Email: christopher.conley@usma.edu TEL: 845-938-4092
Steve Kilczewski, WMRD, ARL, APG, MD 21005
Email: steven.m.kilczewski.ctr@mail.mil TEL: 410-306-0952

A Comparison of Binomial Distribution Methods

David W. Webb and Dr. Patrick Swoboda, ARL

A comparison of binomial distribution methods used to establish an interval estimate of the true probability of armor reliability is presented. In order to develop a probability estimate, there must be a predetermined level of confidence and a lower confidence bound such that we could conclude with a high degree of confidence that the armor package can defeat the threat at some minimum probability. This allows us to solve for the specific number of test trials necessary to satisfy a set confidence level and a lower confidence bound. The three methods of binomial distribution used for comparison are the Clopper-Pearson Method, the Wilson Score Method, and the Jeffreys Method.

KEYWORDS: Binomial Distribution, Interval Estimate, Lower Confidence Bound, Level of Confidence

CONTACT: CDT KIRK Llewellyn, USMA, West Point, NY 10996
Email: Kirk.Llewellyn@usma.edu TEL: 301-873-5433