Air Force Research Laboratory
711th Human Performance Wing

Wright-Patterson Air Force Base, Dayton, OH
Fort Sam Houston, San Antonio, TX

Office of the Chief Scientist

As the Chief Scientist for all of the U.S. Air Force's human-centered research at the Air Force Research Laboratory, I invite you to submit an application to participate in our 2018 Dr. Daniel Repperger Research Intern program. This program posthumously honors Dr. Repperger, who mentored many young people during his 35 year research career with our organization, by providing research opportunities for students to work in one of our facilities under the mentorship of an Air Force scientist. Each of these scientists has been hand-selected to mentor because of their technical knowledge, experience and willingness to help science and engineering students enhance their learning through participation in an actual Air Force research project.

Please review the information and application instructions on page 4 of this brochure to determine your eligibility and then review the research projects on pages 5-40 to see if any match your research interests. If selected for one of the projects, you will have temporary summer employment through our contract with the Oak Ridge Institute for Science and Education (ORISE) to participate in this 10-week research internship at one of our two research locations; Dayton, Ohio or San Antonio, Texas. Along with gaining first-hand research experience, you'll learn the inner workings of an operational laboratory and develop contacts and friendships that will last a lifetime. Again, please review the information in this brochure carefully to understand the specifics of the program before you apply. I look forward to reviewing your application and wish you the best of luck in the selection process.

Rajesh R. Naik, PhD, ST
Chief Scientist
711th Human Performance Wing

WHO WE ARE

Air Force Research Laboratory

AFRL leads the discovery, development and integration of affordable warfighting technologies for America's air, space and cyberspace forces. We are a full-spectrum laboratory, responsible for planning and executing the Air Force's science and technology program. AFRL leads a worldwide government, industry and academic partnership in the discovery, development and delivery of a wide range of revolutionary technologies. The laboratory provides leading edge warfighting capabilities keeping our air, space and cyberspace forces the world's best. Operating from over 40 sites worldwide, AFRL focuses on technologies for air vehicles, human performance, materials and manufacturing, sensors, propulsion, space vehicles, directed energy, information and weapons. The lab employs approximately 5,800 government people (1,400 military and 4,400 civilian personnel). It is responsible for the Air Force's science and technology program of $2.1 billion including basic research, applied research, advanced technology development, and an additional $2.3 billion in externally funded research and development." **AFRL Research Areas**

711th Human Performance Wing

The 711th Human Performance Wing advances human performance in air, space, and cyberspace through research, education, and consultation, accomplished through the synergies created by the wing's three distinct but complementary entities:

The **U. S. Air Force School of Aerospace Medicine (USAFSAM)** is an internationally renowned center for aerospace medical learning, consultation, aerospace medical investigations and aircrew health assessments. The school trains approximately 5,000 students each year. It also performs research on technologies for the rapid detection of chemical, biological and radiological events, hyperbaric medical research and light, durable intensive care capabilities. USAFSAM also has the Nation's only Radiological Assessment Teams available for 24/7 deployment.

The **Human Performance Integration Directorate (711 HPW/HP)** focuses on human performance optimization and sustainment through human systems integration (HSI). The directorate is the bridge among the acquisition communities and lead integration agent for the promotion, guidance, consultation, and implementation of human systems integration. It also provides HSI consulting services and technical advisory support to capability requirements developers, program managers, and engineers throughout the Air Force.

The **Airman Systems Directorate (711 HPW/RH)** leads the U.S. Air Force's human-centered research, discovering biological and cognitive technologies to optimize and protect the Airman's capabilities to fly, fight, and win in air, space, and cyberspace. The Directorate provides a strong in-house research program and extensive research partnerships with industry and academia. Its research team is composed of the most diverse range of technical disciplines in the Air Force to explore the human from the bio-molecular level to the societal behavior level. The Directorate focuses its research in four Core Technical Competencies: Training, Decision Making, Bioeffects and Human-centered Intelligence, Surveillance and Reconnaissance.

AIR FORCE RESEARCH LABORATORY
711TH HUMAN PERFORMANCE WING

REPPERGER RESEARCH INTERN PROGRAM

Dr. Daniel W. Repperger
1942-2010

The Repperger Research Intern Program honors the life and works of Dr. Daniel W. Repperger (1942-2010) a scientist and mentor to many young engineers and scientists. As a researcher in the Air Force Research Laboratory's Human Effectiveness Directorate for 35 years, Dr. Repperger's mathematical and scientific innovations have revolutionized image and network complexity analysis. He received international recognition in haptic controllers, human-machine interface performance enhancement, and mathematical methods development. While Dr. Repperger's significant research accomplishments helped advance the performance of Air Force airmen and the field of human-centered research, his most significant accomplishment may well be the impact he had as a kind and caring mentor of many young Air Force scientists and science and engineering students. Dr. Repperger received a BS and MS in Electrical Engineering from Rensselaer Polytechnic Institute and a PhD in Electrical Engineering from Purdue University. He was a David Ross Research Fellow at Purdue from 1971-1973 and a National Research Council Post-Doctoral Fellow at Wright-Patterson AFB from 1973-1975. A member of Eta Kappa Nu, Tau Beta Pi and Sigma Xi, Dr. Repperger was a Registered Professional Engineer in Ohio and on the Board of Trustees of the Ohio Academy of Sciences. He was a Fellow of the IEEE, Air Force Research Laboratory, American Institute of Medical and Biological Engineering, the Ohio Academy of Science and the Aerospace Medical Association. Dr. Repperger authored over 400 technical journal articles, reports and conference publications, was selected as Associate Editor of five international journals and obtained 14 U.S. patents and 28 Air Force invention registrations. His honors and awards include the Harry G. Armstrong Scientific Excellence Award, Human Effectiveness Directorate Mentor of the Year, IEEE Third Millennium Medal Winner and the IEEE Dayton Fritz Russ Award. Dr. Repperger is listed in the Who's Who in Science and Engineering and the American Men and Women of Science.

REPPERGER RESEARCH INTERN PROGRAM
INFORMATION AND APPLICATION INSTRUCTIONS

Program Dates:	June 4 – August 10, 2018 (arrive June 3 – depart August 11)
Program Hours:	40 hours per week Monday-Friday (actual hours set by mentor)
Stipend:	$12,000 for 10-week period
Lodging:	Student's expense - Click on items below for lodging options: • **Apartment Finder** • **Local Hotel Search**
Research Locations:	Wright-Patterson AFB, Dayton, OH or Fort Sam Houston, San Antonio, TX
Number of Positions:	Approximately 15 students will be selected for participation
Requirement:	• Enrolled in school seeking an undergraduate or advanced STEM degree. • Must be a U.S. citizen
Final Report:	All selectees are encouraged to prepare a PowerPoint presentation or poster by end of internship. Notifications will be made to those required to present their poster or slide deck during our intern summer close-out summit.
Application Deadline:	January 21, 2018 at 5:00 p.m. EST
Application:	Apply through this link: **http://www.orau.org/maryland/repperger.html** You will be required to provide; Curriculum Vitae, Copy of Transcript (unofficial is okay), copy of proof of U.S. citizenship, Letter of recommendation from current faculty adviser (if sent directly from your adviser, please have them add your name in the subject line)
Proof of U.S Citizenship (submit 1 of the items shown on list with application)	• **Copy** of U.S. Passport • **Copy** of Certified birth certificate issued by the city, county or state of birth • **Copy of** Consular Report of Birth (of U.S. citizen) Abroad or Certification of Birth • **Copy** of Naturalization Certificate • **Copy** of Certificate of Citizenship
Computer Access	Students selected will be required to undergo a National Agency Check prior to being granted access to government computer systems.
Notification:	Students selected for the program will receive a fellowship with the Oak Ridge Institute for Science and Education (ORISE) to perform intern duties in the 711th Human Performance Wing.
For More Info:	Mike Reynolds, 937-255-7629, **mike.reynolds.ctr@us.af.mil**

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RP-18-01

BASE123: DEEP LEARNING APPLICATION OF A RECURRENT NEURAL NETWORK FOR NATURAL LANGUAGE PROCESSING OF NUCLEOTIDE POLYMER STRUCTURES DEMONSTRATING PHYSIOLOGICAL EFFECTS OF INTEREST TO THE USAF

PROJECT SYNOPSIS: The Repperger intern will develop vital skills in bioinformatics with a specific focus on HPC-oriented applications in Python, R and C++. Leveraging 14M HPC hours and the work of previous interns, Base123, Phase II, deploys a Recurrent Neural Network (RNN) implemented in the Microsoft Cognitive Toolkit (MCT) to explore the use of Natural Language Processing (NLP) as a means of analyzing three-dimensional nucleotide polymer data in secondary structure format. During Phase I, in addition to production of the underlying data library consisting of 30M+ files, Dr. Huff's team developed multiple data convertors to transform these structural data from native Rosetta and ViennaRNA formats into a proprietary text-based storage imminently suitable for rapid training of RNN configurations devoted to NLP. A proprietary genomic catalog derived from NCBI data containing a novel collation of taxonomic and protein-coding information will supplement these training data to develop a high throughput method for predicting (and, ambitiously, perhaps folding *de novo*) nucleotide structural motifs demonstrating significant control of eukaryotic cells with a specific focus on identified effects of interest to the USAF. The selected Repperger intern will use state-of-the-art front-end equipment to learn new programming skills combined with a cutting-edge focus in computational biology to develop the next generation of *in silico* tools crucial to advancing biological investigations into the last half of the Twenty-First Century.

STUDENT LEVEL/DISCIPLINE NEEDED:
Master's, Bachelor's / Physics, Mathematics, Computer Science

RESEARCH LOCATION: Molecular Bioeffects, Wright-Patterson AFB Dayton, OH

RESEARCH ADVISER: Steven Huff, PhD

DEGREE: Bioinformatics, University of Houston, 2011

Upon arrival at the AFRL (RHDJ) in December of 2011, Dr. Huff labored to establish a state-of-the-art bioinformatics laboratory to investigate the role RNA structural motifs play within eukaryotic cells. The Biological Informatics Group (BIG) within RHDJ has since acquired substantial applications development capabilities with implementations targeting DoD High Performance Computing (HPC) supercomputers, as well as iOS (Apple), Android (Google) and Windows 7-10 devices. These implementations include a high-throughput, parallelized data management pipeline (Base123) running on the HPC, which Dr. Huff previously used to generate a data repository consisting of 30M+ RNA structure files produced via execution of 14M HPC hours allocated since 2013, and a variety of ancillary software tools developed in Python, R, and C++. Currently, Dr. Huff uses Deep Learning methodologies in the form of a Recurrent Neural Network implemented in the Microsoft Cognitive Toolkit (deployed on Thunder) and applied to Natural Language Processing protocols adapted to the analysis of the project's vast biological data set.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-02

COGNITIVE AND HUMAN FACTORS OF ANOMALY DETECTION

PROJECT SYNOPSIS: Many jobs require a person to detect anomalies in routine data input streams. Tasks range from those of Air Traffic Controllers and rush-hour traffic reporters who view video-feeds under real-time pressure; whereas medical researchers and stock market analysts follow large volumes of text data over days to spot new breakouts and trends. Unfortunately, key signals often go undetected and planes crash or markets plummet. We need answers to three questions: How prevalent are failures to detect both "obvious" and subtle items? Why do detection failures occur? How do we improve and aid human monitors? Perceptual and cognitive research shows that people, even when actively looking for anomalies that they have been forewarned about, often miss glaring oddities in dynamic events when they are engaged in information gathering tasks. In additional to psychological research on "change blindness" and "inattention blindness," personality and thinking styles may affect anomaly detection, but the research is still in its infancy. Research projects should focus on the reasons for detection failures and improvement, but also be aware of false alarms and performance quantification. Students can research various factors which contribute to anomaly detection and inattention blindness such as (1) Display factors (e.g., number, position, motion, pattern, & complexity of elements, (2) Task factors (e.g., number of tasks, communications, and distractions), (3) Human factors (e.g. training, workload, personality, culture, teamwork). Student will be involved at all phases of research including hypothesis generation, experimental design, data analysis, and documentation. Original ideas encouraged.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Psychology, Human Factors, Engineering

RESEARCH LOCATION: Human Analyst Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Rik Warren, PhD

DEGREE: Experimental Psychology, Cornell, 1975

Dr. Warren is a National Research Council Post-Doctoral Advisor and has mentored numerous NRC post-docs and graduate students. He is a perceptual psychologist and currently is interested in failures of perception to detect critical items in rich natural environments, for example, inattention and change blindness. He is also developing statistical methods for finding anomalies in large and small datasets. The role of cultural factors in perception and mis-perception is also central. He serves on three journal editorial boards and is on the program committees of several social dynamics and complex systems conferences.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-03

FROM INSIGHTS IN SOCIAL MEDIA TO INDICATORS OF BEHAVIOR

PROJECT SYNOPSIS: Social media has dramatically changed the information and communications environment landscape, allowing people from all walks of life to exchange information with one, few, or many without physical constraints. It has become a massive source of information and offers a platform for researchers and scientists to study human behavior and activities at scale. Unfortunately, this seemingly unlimited data does not come without challenges; if nothing else, it presents a very unique set challenges that traditional data mining and machine learning methods cannot overcome. As an example, studies have shown evidence of demographics bias in some social media sources due to users who are much younger than the general population. Another form of bias can come from malicious or automated accounts that proliferate the environment with massive amounts of content intended to skew the data. Researchers are now challenged to identify these biases, develop novel ways to evaluate the data, filter the noise, visualize implicit social links, and overcome the "big data" problem all in an effort to understand individual and group dynamics in the social media environment. Research projects should focus on potential solutions to any of the aforementioned challenges (or others related to social media data) with the ultimate goal of effectively leveraging social media information to better understand human behaviors and detect or predict events or activities. Student will be involved at all phases of research including hypothesis generation, experimental design, data analysis, and documentation. Original ideas are encouraged.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Social Science, Computer Science, Engineering

RESEARCH LOCATION: Human Analyst Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Rik Warren, PhD

DEGREE: Experimental Psychology, Cornell, 1975

Dr. Warren is a National Research Council Post-Doctoral Advisor and has mentored numerous NRC post-docs and graduate students. He is a perceptual psychologist and currently is interested in failures of perception to detect critical items in rich natural environments, for example, inattention and change blindness. He is also developing statistical methods for finding anomalies in large and small datasets. The role of cultural factors in perception and mis-perception is also central. He serves on three journal editorial boards and is on the program committees of several social dynamics and complex systems conferences.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-04

TRUST IN COMPUTER CODE

PROJECT SYNOPSIS: Computer code has become a ubiquitous aspect of modern society. The trust in computer code project explores the factors of the computer code that influence programmer's perception of trustworthiness of the code and reuse. The project is inter-disciplinary in that it applies psychological theories and models to experiments in the computer science domain. The project seeks to determine how programmers perceive, evaluate, and decide to reuse computer code. The relative dearth of information on programmer's perception is problematic for the use of computer generated code, as code may not be trusted if it does not appear to meet the user's expectations. The goal of the research project is to explore the aspects of code that influence a programmer's perceptions, evaluations, and decision to reuse code so that human factors guidelines can be created to design computer generated code the programmer trusts and is willing to use.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD/ Computer Science, Cognitive Science, Human Factors
Masters, Bachelor's /Computer Science, Cognitive Science, Human Factors Psychology

RESEARCH LOCATION: Human Trust and Interaction, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Gene Alarcon, PhD

DEGREE: Industrial Organizational Psychology, Wright State University, 2009

Dr. Gene Alarcon is a research psychologist in the Air Force Research Laboratory's Human Insight and Trust Branch. His current research interests include trust in automation, trust in computer code, individual differences in trust, and the role of biases in trust.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-05

INVESTIGATING PRIMARY AND SECONDARY BIOEFFECTS OF PHOTOTHERMAL AND PHOTOCHEMICAL EXPOSURE

PROJECT SYNOPSIS: The damaging effects of lasers on cells depends upon the wavelength and intensity of the irradiation, as well as the overall duration of exposure. Photochemical damage is correlated with severe oxidative stress (secondary effects), but little is known about which enzymes are the prime suspects for photon absorption (primary effects). Absorption by chromophores like melanin and water can lead to temperature rises (primary effects) that cause damage via thermal destruction of macromolecules (secondary effects). Our laboratory is interested in the biophysical alterations in the key biomolecules involved in thermal (secondary effects) and photochemical (primary effects) damage. At the cellular level, we study laser bioeffects using microthermography (IR imaging), Raman spectroscopy/imaging, and fluorescence-based microscopic detection of damage, metabolic perturbations, and macromolecule localization. At the molecular and atomic level, we use fluorescence, fluorescence anisotropy, Raman spectroscopy, transient absorption, and 2-D IR spectroscopy. Biophysical data can supply valuable input for computational models, providing revolutionary enhancements for predicting risk of laser damage on the modern battlefield.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Biophysics, Biochemistry, Chemistry

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Michael Denton, PhD

DEGREE: Biochemistry, Kansas State University, 1991

Dr. Denton is a Research Biochemist at the Air Force Research Laboratory's Optical Radiation Branch where he has studied laser-tissue interactions in cultured cells since 2000. His research interests include the study of cellular processes responsible for photothermal and photochemical damage, and the development of computational models describing those processes. Dr. Denton has 28 peer-reviewed publications and is an active member of the International Society for Optics and Photonics (SPIE), AAAS, ARVO, and the American Society for Photobiology.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-06

EVALUATION OF COLOR CONTRAST SENSITIVITY TESTS

PROJECT SYNOPSIS: Cone Contrast Tests (CCTs) have been developed for color vision evaluation. Cone Contrast Tests as well as other vision tests might also be used to evaluate the effects of LEP on visual performance. During the last several years, existing color contrast tests have been modified and new contrast sensitivity tests have been developed, thus expanding the selection of tests to implement in research protocols. The goal of the project is three-fold: identify the similarities and differences of the color vision tests, determine the utility of the vision tests to evaluate LEP, and identify the most appropriate tests for the purposes of LEP evaluation.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master's, Bachelor's/ Experimental Psychology, Human Factors Psychology, Psychology

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Julie Lovell, PhD

DEGREE: Decision Sciences, Walden University-Minneapolis, 2010

Dr. Julie Lovell joined the U.S. Air Force Research Lab in 2004 where she worked on the Human Information Processing in Dynamic Environments research program at Wright Patterson, AFB. From 2006-2011, Dr. Lovell joined the Organizational Research Effectiveness Team focusing on assessing decision-making tools in Air Operations Centers (AOC), conducting organizational assessments and facilitating strategic alignment workshops. After finishing two career broadening assignments and one civilian deployment to Afghanistan, Dr. Lovell moved to San Antonio, TX to join the Optical Radiation Branch at the Tri-Services Research Lab. The focus of her work is on the impact of high transmission laser eye protection (LEP) and tunable LEP on visual and human performance.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-07

HARNESSING SYNTHETIC BIOLOGY TO ENGINEER PROBIOTICS TO MODULATE CORTISOL LEVELS

PROJECT SYNOPSIS: High levels of stress & cortisol induced by stress impose a significant burden on health such as metabolic syndrome and psychological maladaptation. Synthetic biology offers a path to modulating this response through engineering circuits that sense persistently high cortisol levels and restore equilibrium. We are engineering totally synthetic transcription factors (STF) that recapitulate the domain structure of the glucocorticoid receptor (activator, ligand binding domain and DNA binding domain) & creating libraries of STF's that differ in their ability to sense cortisol and activate transcription thus enabling tuning of cortisol control circuits in a probiotic eukaryote Saccharomyces boulardii.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Biophysics, Computational Modeling, Molecular Biology

RESEARCH LOCATION: USAF School of Aerospace Medicine, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Heather Pangburn

DEGREE: Molecular Toxicology & Cancer Pharmacology, University of Colorado 2007

Heather Pangburn, PhD, is a Research Toxicologist in the USAF School of Aerospace Medicine, Department of Aeromedical Research, overseeing and conducting research related to Force Health Protection to include synthetic biology and precision medicine/total exposure health efforts, in vitro toxicology, hazard detection and air quality monitoring to evaluate human risk. Dr. Pangburn brings 10+ years' experience in toxicology, molecular biology, cell biology and biochemistry. She received her PhD in Molecular Toxicology from the University of Colorado Health Sciences Center wherein she examined the biologic and biochemical mechanisms of the chemopreventive effects of non-steroidal anti-inflammatory drugs. Heather subsequently executed her postdoctoral fellowship in the Regenerative Medicine and Stem Cell Biology Program at the University of Colorado Denver studying genetic pathways and identifying genetic alterations that occur in acquired skin diseases such as cancer. Following her fellowship, Dr. Pangburn served as Research Scientist and Radioprotection Team Lead in the Human Signatures Branch of Air Force Research Laboratories 711th Human Performance Wing where she led a team of scientists in identifying and exploiting molecular mechanisms to provide enhanced human performance and injury protection to the warfighter in high radiation environments.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-08

INTEGRATIVE PHENOTYPING FOR PREDICTIVE TOXICOLOGY

PROJECT SYNOPSIS: Protecting the health of military operators involves assessing, treating and developing countermeasures to illness, injury, or exposure to foreign substances commonly encountered in harsh and varied environments. A complicating factor in this is the wide range of responses that exist for every treatment or exposure due to underlying differences in each person's genetic profile. Understanding how genetics influences response to chemical exposure is critical for advancing personalized medicine and the Air Force's Total Exposure Health (TEH). The goal of this specific internship effort is employ methods such as biostatistics, machine learning and data mining to create software (Widgets, databases, GUIs, etc) to integrate with unique high-resolution phenotypic signatures that are characteristic of different classes of cellular toxicants, with the goal of rapid comparison and utilization of data from cellular models and performing phenotype prediction using genetic data.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Bioinformatics, Biomedical Engineering, Mathematics

RESEARCH LOCATION: USAF School of Aerospace Medicine, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Heather Pangburn

DEGREE: Molecular Toxicology & Cancer Pharmacology, University of Colorado 2007

Heather Pangburn, PhD, is a Research Toxicologist in the USAF School of Aerospace Medicine, Department of Aeromedical Research, overseeing and conducting research related to Force Health Protection to include synthetic biology and precision medicine/total exposure health efforts, in vitro toxicology, hazard detection and air quality monitoring to evaluate human risk. Dr. Pangburn brings 10+ years' experience in toxicology, molecular biology, cell biology and biochemistry. She received her PhD in Molecular Toxicology from the University of Colorado Health Sciences Center wherein she examined the biologic and biochemical mechanisms of the chemopreventive effects of non-steroidal anti-inflammatory drugs. Heather subsequently executed her postdoctoral fellowship in the Regenerative Medicine and Stem Cell Biology Program at the University of Colorado Denver studying genetic pathways and identifying genetic alterations that occur in acquired skin diseases such as cancer. Following her fellowship, Dr. Pangburn served as Research Scientist and Radioprotection Team Lead in the Human Signatures Branch of Air Force Research Laboratories 711th Human Performance Wing where she led a team of scientists in identifying and exploiting molecular mechanisms to provide enhanced human performance and injury protection to the warfighter in high radiation environments.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-09

FRACTIONAL ORDER BIOPHYSICS

PROJECT SYNOPSIS: Research has shown that biophysical processes, such as laser-tissue interaction, deviate from the predictions given by traditional mathematical models for short laser exposure times. In general, it was found that the shorter the exposure time is, the stronger the deviation will be. However, generalizing these models by recasting them as fractional order differential equations have resulted in models that show high agreement with experimental observation regardless of exposure duration. The purpose of this project is to analyze these new equations that employ elements of the fractional calculus and apply them to other biophysical phenomena, beginning with thermal diffusion resulting from laser heating. Methods will include an introduction to the fractional calculus; a powerful branch of mathematics dealing with differentiation and integration of arbitrary order, and the development of new analytical and/or numerical models as needed. Secondary objectives will include the development of models that have the capability to simulate combinations of different biophysical processes.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Biomedical Engineering, Physics, Mathematics

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Andrew Wharmby, PhD

DEGREE: Biomedical Engineering, University of Texas SA, 2013

Dr. Andrew Wharmby is a Research Biomedical Engineer in the Optical Radiation Branch at the Air Force Research Laboratory Human Effectiveness Directorate. He joined the Air Force Research Laboratory in 2006 where he focused on the development and application of digital image and video processing algorithms, automated instrumentation control, and data analysis for the Vision Science team. He then moved to the Modeling and Simulation team where he developed finite element analysis code for simulating real-time dynamic thermal lensing events in the human eye. Upon completing his Ph.D., he returned to RHDO where he now focuses on the application of fractional calculus to solve problems involving directed energy effects on materials and biological systems.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-10

HUMAN-MACHINE TEAMING (HMT) IN FULL MOTION VIDEO TO SUPPORT DYNAMIC TACTICAL INTELLIGENCE

PROJECT SYNOPSIS: Effective HMT must address numerous issues including: restricted attention and cognitive bandwidth, shared situational awareness, trust in automation, error rates, confidence measures, and strengths and weaknesses of both the machine and human in accomplishing a joint task. Human-machine teams are heterogeneous by nature, making the "optimization" of HMT more complex. These differences must be capitalized in any HMT domain to build effective systems capable of outperforming either human or machine working independently. Insufficient knowledge exists about the fundamentals of effective teams as it relates to human decision making processes in situ and human trust in automation. This lack of knowledge leads to brittle solutions and poor designs. This project will support a series of studies modeling the cognitive load, task load, and confidence/trust of Full Motion Video (FMV) exploitation team in order to assess where human-machine teaming can positively impact overall performance of processing, exploitation, and dissemination (PED). FMV domains are dynamic data-driven applications systems that include both machine analytics and human exploitation where timely responses are required to support real-time operations. This set of studies will provide the basis of a HMT workflow model for streamlining FMV exploitation, however the impact of this research is broad in scope, with the potential to save lives across intelligence missions due to faster relay of accurate information and application-dependent workflow modeling of effects-based performance.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's / Human Factors, Psychology, Information Sciences

RESEARCH LOCATION: Human Analysis Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Darrell Lochtefeld, PhD

DEGREE: Engineering (Industrial Systems & Ops Research), Wright State University, 2001

Dr. Lochtefeld's expertise includes system simulation, software development, software architecture and design, machine intelligence, and ISR applications. He has 20 years of experience working with the DoD, including over 10 years as a civil servant. Dr. Lochtefeld has worked on large source code development projects as well as smaller research-based developments grounded in the science of artificial intelligence (AI). His research interests include system-of-systems and system level design, artificial intelligence and pattern recognition, cognitive function and meaning making, human machine teaming, and practical ISR application development. Dr. Lochtefeld is a part of a multi-disciplinary team of researchers, including research psychologists, engineers, programmers, and technology evaluators.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-11

ANALYTICS FOR REMOTE COMBAT EXPOSURE ASSESSMENT (ARCEA)

PROJECT SYNOPSIS: "Remote combat stress" has been identified as a significant contributor to posttraumatic stress and other negative psychological outcomes for ISR operators, with incidence rates that may match or exceed those found among deployed combat units. As remote engagement increasingly becomes the de facto modus operandi for combat operations, the number of warfighters directly experiencing "deployed-in-place" combat exposures continues to similarly increase, encompassing not only ISR analysts but also remotely piloted aircraft (RPA) crews, tactical coordinators, and other real time and post-mission support elements. Despite representing a well-recognized risk, there currently exist no validated methods to accurately and unobtrusively track remote combat exposures and associated mental health risks. This research seeks to improve the health, wellness, and operational effectiveness of remote combat operators by developing methods and technologies to (1) identify and monitor exposures to High Risk Exposure Events (HREE) and (2) inform prioritization and interventions to maximize efficacy of resilience and mental health resources and minimize exposure rates and negative behavioral health effects. The application of text analytics to existing mission data sets will drive the assessment of operator health and wellness, in turn enabling wider identification of and eventual intervention for at-risk service members.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Human Factors, Psychology, Information Sciences

RESEARCH LOCATION: Human Analysis Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Daniel J. Zelik, PhD

DEGREE: Industrial and Systems Engineering, Ohio State University, 2012

Dr. Zelik is a Senior Cognitive Systems Engineer in the Human-Centered Intelligence, Surveillance, and Reconnaissance (ISR) Division with expertise in Intelligence & Information Analysis, Human-Centered Research & Development, and Technology Design & Assessment. He serves as a lead technical contributor to the ISR Analyst Performance program, focusing on discovery and development of technical solutions for a spectrum of high priority initiatives that support DoD-wide intelligence missions. His research interests include how professional intelligence analysts assess analytical rigor, cope with data overload, and overcome challenges to effective analysis.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-12

VISUAL ANALYTICS FOR WIDE-AREA MOTION IMAGERY (WAMI)

PROJECT SYNOPSIS: Full Motion Video (FMV) Processing, Exploitation, and Dissemination (PED) operations are performed by teams of analysts who share responsibility for viewing and interpreting real time FMV data streams, identifying activities of interest, capturing those observations in a persistent digital form, and disseminating their findings to intelligence customers. Increasingly, new sensor technologies make it possible to perform FMV PED on Wide Area Motion Imagery (WAMI) feeds, which provide a significantly greater field of view over areas of interest. The resulting data streams generated by WAMI collection are thus beyond the capacity of individual analysts or analyst teams to comprehensively exploit using traditional analysis methods. Moreover, current tools and techniques for exploiting WAMI were originally developed to support "top down" FMV PED operations, where collection focuses on specific targets of known or suspected intelligence value. These approaches fail to fully capitalize on the potential for WAMI to enable "bottom up" analysis that is driven by activity in the world, rather than by prior knowledge of a target. Novel approaches for visualizing data are needed to assist analysts in identifying mission-relevant regions within wide area feeds. This effort seeks to develop operational concepts and data visualizations to team Airman with analytics and automation that provide decision support for attention direction and management and assist in establishing and maintaining situation awareness during both real time and forensic analysis of WAMI data.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Human Factors, Psychology, Information Sciences

RESEARCH LOCATION: Human Analysis Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Daniel J. Zelik, PhD

DEGREE: Industrial and Systems Engineering, Ohio State University, 2012

Dr. Zelik is a Senior Cognitive Systems Engineer in the Human-Centered Intelligence, Surveillance, and Reconnaissance (ISR) Division with expertise in Intelligence & Information Analysis, Human-Centered Research & Development, and Technology Design & Assessment. He serves as a lead technical contributor to the ISR Analyst Performance program, focusing on discovery and development of technical solutions for a spectrum of high priority initiatives that support DoD-wide intelligence missions. His research interests include how professional intelligence analysts assess analytical rigor, cope with data overload, and overcome challenges to effective analysis.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-13

APPLICATION OF VOLUMETRIC CNNS FOR HUMAN ACTION RECOGNITION FROM LIDAR POINT CLOUDS

PROJECT SYNOPSIS: Convolutional neural networks (CNNs) have demonstrated outstanding performance in image classification due to its capability of learning nonlinear representation of complex, multilevel features from raw imagery. Its application domain is also extended to human action recognition. With the proliferation of 3D sensors, such as LIDAR used in self-driving vehicles, there are needs for human action recognition from LIDAR point clouds. When compared to the images of regular RGB-D cameras, LIDAR data is nosier and has lower resolution, due to the greater standoff distance. This could make volumetric CNNs an attractive alternative to 2D depth image based CNNs. The former allows direct learning of 3D spatial features, instead of latter's indirect 2D features from depth image. Currently, volumetric CNNs are studied mostly for 3D object classification. This research calls for the development of volumetric CNNs coupled with robust and efficient temporal information encoding for human action recognition from LIDAR point clouds. Synthetic LIDAR data will be provided for experimental uses. Performance comparison between volumetric and depth image based CNNs on LIDAR point clouds is desired.

STUDENT LEVEL / DISCIPLINE NEEDED:

PhD, Master's, / Computer Science, Electrical Engineering, Mathematics

RESEARCH LOCATION: Human Signatures, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Huaining Cheng, PhD

DEGREE: Computer Science, Wright State University, 2016

Dr. Huaining Cheng is a Research Computer Scientist in the Airman Systems Directorate, 711th Human Performance Wing, Air Force Research Laboratory. His research involves developing computer vision and pattern recognition algorithms for learning and characterization of humans and activities in aerial surveillance and target recognition tasks. Another focus of Dr. Cheng's research is physics-based synthetic sensor data generation to address the limited variations on human signatures in many machine learning datasets. Dr. Cheng's past activities cover a wide range of fields including online data analytics and management, 3D point cloud shape modeling and recognition, biodynamics modeling and simulation, and optimization of nonlinear metal forming process.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-14

TRUST IN SURGICAL ROBOT

PROJECT SYNOPSIS: Robotic surgical systems are expected to be increasingly prevalent in future medical teams. These systems are complex and will contain automated functions as the technology advances. In the future, medical personnel may be partnered with surgical robotic systems. This will require a human to off-load certain procedures to a robot, thus, making trust a key component that will influence medical human-robot team effectiveness. The goal for this research effort is to explore the drivers of trust and reliance in the surgical robots. Both, experimental and interview methods are planned to be used. For example, we might explore the influence of surgical robot enhancements (e.g., haptic feedback) on surgeon's trust and reliance in a simulated task environment.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Human Factors, Experimental Psychology, Biomedical Engineering

RESEARCH LOCATION: Human Trust and Interaction, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISOR: Svyatoslav Guznov, PhD

DEGREE: Experimental Psychology, University of Cincinnati, 2011

Dr. Svyatoslav Guznov is a research psychologist at the Air Force Research Laboratory, Wright-Patterson Air Force Base. He is conducting research in the areas of human-machine interaction, trust in automation, and performance.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-15

DEEP INTEGRATION OF PARAPHRASE FEATURES IN NEURAL MACHINE TRANSLATION ARCHITECTURES

PROJECT SYNOPSIS: Previous work has shown inducing variations in data used to train Neural Machine Translation (MT) systems can result in a sizable decrease in training time while maintaining translation quality. This approach modifies the data statically before the training process begins. We propose to directly add features detailing variations in input sentences to the existing feature space used in model training. We theorize access to this linguistic data will ultimately improve the quality of MT systems trained with these additions.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Computer Science

RESEARCH LOCATION: Human Trust and Interaction, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Jeremy Gwinnup

DEGREE: Computer Science, Wright State University, 2003

Mr. Gwinnup is a Research Computer Scientist in the Human Language Technology Team of the Airman Systems Directorate at Wright-Patterson AFB in Dayton, OH. Research interests include statistical and deep-learning based machine translation, natural language processing and computational linguistics.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-16

ELECTRONIC/ELECTROCHEMICAL/OPTICAL SENSOR FOR MOLECULAR BIOMARKERS

PROJECT SYNOPSIS: Molecular biomarkers indicative of human physiological and psychological status vary person-to-person and the measurement point of the time. Developing personal chemical and biochemical sensors that enable the profiling/reporting biomarker data throughout 8-24hr time frame of individual operators will greatly benefit USAF personnel health and performance. Zero footprint, noiseless, and low-powered sensing platform without the need for calibration and drift correction is highly desirable in developing a wearable or attachable personal sensor suite. Miniaturizing device size and increasing sensitivity and selectivity of chemical/biochemical/optical sensors are key elements in building such sensor suites. In this research, the structural interactions and functionalities of nano device platform and biomolecule hybrids are systematically probed by using both experiments and computations. The hybrid system is further explored for its capability as a sensor for the target of interest. The sample collection, delivery, signal processing, and device-to-device communication for the miniaturized sensors and devices are to be explored collaboratively with both internal and external partners.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Biomedical Engineering, Electrical Engineering, Chemistry

RESEARCH LOCATION: Human Signatures, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Steve Kim, PhD

DEGREE: Polymer Science, University of Connecticut, 2007

Dr. Kim serves as a Research Physical Scientist at the Human Signatures Branch. Dr. Kim obtained his Ph.D. degree in Polymer Science from the University of Connecticut (2007). After completing National Research Council Postdoctoral Fellowship (2007-2010), Dr. Kim continued to work as a contract research scientist at AFRL (2010-2016). Dr. Kim's research interest is developing electronic/electrochemical/optical molecular biomarker and chemical sensors for human performance monitoring and force health protection. Dr. Kim leads research on developing an electronic biosensor platform for trace level cognitive molecular biomarkers, a crucial information to increase the human performance monitoring/assessment capability at USAF. Dr. Kim's work focuses on bioreceptors and device platforms that enable miniaturization and wearable electronic and electrochemical biomarker sensing. His pioneering nano material study and analytical strategy have unveiled the governing factors in the biotic-abiotic interface for a key electronic sensing platform, single atomic layer graphene, and peptides. Dr. Kim's current research on volatile organic compound gas sensor development revealed that the carbon nanotube electronic sensor outperforms commercial off the shelf products by integrating an innovative biomimetic chemical receptor for low ppm to sub ppm level gas target in near zero humidity environment, an equivalency to inhaled air in a high altitude fighter jet. Dr. Kim has authored and coauthored 41 peer-reviewed scientific journal articles including his main-authored AFRL works that were recognized as a "Top20 most read article on the web in a year" and a "Top20 most read article on the web in a month" in a high impact journal, Nano Letters.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-17

PSYCHOLOGICAL FACTORS THAT INFLUENCE INTELLIGENCE ANALYST PERFORMANCE

PROJECT SYNOPSIS: Eyes-on-Analysts view full motion video feeds to identify Essential Elements of Information (i.e., targets) for long periods of time. This research focuses on cognitive, affective, perceptual and neurological factors that can influence how an analyst processes and remembers incoming information in a surveillance environment. Several psychological constructs are relevant to surveillance such as visual search, sustained attention (i.e., vigilance), implicit learning, prospective memory, and schemata. The overarching aim of this research effort is to gain insight into the psychological processes that are involved in the duties of an analyst so that in the future we can develop tools to enhance their performance. Students will have a chance to develop their own project as well as assist with ongoing projects, communicate with each other to share and synchronize data, and perform basic statistical analysis.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Experimental Psychology, Cognitive Science, Human Factors Psychology

RESEARCH LOCATION: Human Analyst Augmentation, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Kathleen Larson, PhD

DEGREE: Experimental Psychology, , University of Nevada, Las Vegas, 2017

Dr. Larson is a Research Psychologist for the Air Force Research Laboratory's Human Analyst Augmentation Branch (711/ RHXM). Dr. Larson's background is in cognitive psychology and she is currently interested in how humans focus attention and remember information in real world environments.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-18

FROM COUPLING TO TRUSTING: ENGENDERING TRUST IN HUMAN-MACHINE TEAMS VIA SYNTHETIC PHYSIOLOGICAL AND BEHAVIORAL COUPLING

PROJECT SYNOPSIS: Embodied artificial agents, with increasingly sophisticated motor skills and refined anthropomorphic features, are likely to become frequent partners in several types of near-future workplaces, including military environments. The incorporation of human-like characteristics not only provides a means for increased functionality in these agents, but also increases their spectrum of social affordances, which may in turn provide avenues for designers to intentionally influence socio-behavioral interactions with humans. As an example, advanced motor capabilities, combined with anthropomorphic characteristics, provide a pathway for the agent to purposefully engender trust and liking by establishing physical rapport with their partners in the form of mimicry and mirroring. Additionally, it is known that many support processes associated with interpersonal coordination and synchronization in humans, such as breathing and postural sway, become coupled unintentionally, often without the awareness of the coupled individuals. Such subtle factors have been demonstrated to be related to trust in human-human teams, and may even drive changes in measured trust and liking constructs. As robots lack the physiological responses of humans, however, physiological coupling in human-machine teams has not previously been considered. A potential novel approach, then, is to endow the machine agent with synthetic physiological "signals" that could be detected by their human teammates. These signals could provide an additional informational link between human and robot teammates that could facilitate coupling, improving liking and trust of the machine agent. Furthermore, these effects could plausibly interact with effects associated with more overt behavioral coupling, which have been demonstrated to influence trust and liking of both human and robot teammates. Knowledge of the combined effects of behavioral and synthetic physiological coupling on interaction outcomes can inform design decisions that may facilitate agent trust and liking, which in turn can lead to faster human-machine team development and enhanced workflow. The goal for this research project is to investigate the influence of overt behavioral coupling and synthetic physiologically-based coupling on human trust and liking of an embodied artificial agent. We predict that conditions featuring opportunities for physiological and behavioral coupling will increase measures of trust and liking in participants. This research may pave the way for simple, cost-effective enhancements to embodied agents that might facilitate formation of trust and liking that can mediate successful team interactions.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Human Factors Psychology, Experimental Psychology, Psychology

RESEARCH LOCATION: Applied Neuroscience and Physiology, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Greg Funke, PhD

DEGREE: Human Factors Psychology, University of Cincinnati, 2007

Dr. Funke is an Engineering Research Psychologist in the Air Force Research Laboratory's Applied Neuroscience Branch. His current research foci include human-machine teaming and understanding team processes that contribute to team successes and failures.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-19

PAIN MANAGEMENT IN EN ROUTE CARE

PROJECT SYNOPSIS: Pain management is critically important to the patients in the military health system and VA facilities. Vigilance and concern for pain management, including the implementation of pain management programs, is a high priority for the Aeromedical Evacuation (AE) environment. Even though pain management is well established in civilian healthcare, the AE environment is substantially different and descriptions of optimal pain management are less described. The overall goal of this body of work is to describe en route pain management during AE, develop or modify existing pain management interventions to be optimized in the AE environment and identify long term consequences of acute pain management through research. Students can work with a multidisciplinary research team including nurses, engineers, and information technology specialist to address pain management research in AE. Ongoing projects include development of a patient-directed electronic application for acute pain assessment and research of non-pharmacological pain interventions to apply in the AE environment. Student can be involved in all phases of research including research generation, design, analysis, and developing dissemination products.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master's/ Nursing Research, Human Factors Psychology, Human Factors
Bachelor's/ Biology, Psychology, Biomedical Engineering

RESEARCH LOCATION: USAF School of Aerospace Medicine, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Maj Julie Roseboro

DEGREE: Health Promotion, Trident University International, 2007

Major Roseboro is Junior Nurse Researcher and Site Manager in the Department of Aeromedical Research at Wright Patterson Air Force Base in Dayton, Ohio. She is certified as an adult critical care nurse (CCRN). She has 17 years of clinical nursing experience with Operation Iraqi Freedom and Enduring Freedom deployment experience. Major Roseboro is working in research to enhance the training of Aeromedical Evacuation (AE) and Critical Care Air Transport Team (CCATT) members.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-20

THE IMPACT OF GENETICALLY VARIABLE METABOLIC FACTORS ON FORCE HEALTH PROTECTION OUTCOMES

PROJECT SYNOPSIS: The focus of our research is to develop human stem cell-based assays to identify genetic markers that correlate with organ phenotypic responses following toxic chemical and environmental exposure situations. This includes the use of recombinant DNA modification tools to generate genetic variability, and the use of proteomic and metabolomic analysis as well as cell-based assays for drug/toxin screening in a high-content screening environment. The overall goal of our studies is to identify genetic factors that play a role in human performance and need to be addressed through individualized force health protection. The research is linked to data processing by bio-computational analysis for integration into physiology-based models. The models generated are aimed towards outcome prediction in individuals with different genetic backgrounds and for improvement of prevention/human physiology requirements, first-response medical intervention and development of novel therapeutic regimens. Experience/Expertise with C++, Java, strong analytic and problem solving skills, data management, and/or statistics is preferred.

STUDENT LEVEL / DISCIPLINE NEEDED:

PhD, Master's, Bachelor's/ Information Science, Computer Science, Biomedical Engineering

RESEARCH LOCATION: USAF School of Aerospace Medicine, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Heather Pangburn, PhD

DEGREE: Molecular Toxicology & Cancer Pharmacology, University of Colorado, 2007

Heather Pangburn, PhD, is a Research Toxicologist in the USAF School of Aerospace Medicine, Department of Aeromedical Research, overseeing and conducting research related to Force Health Protection to include synthetic biology and precision medicine/total exposure health efforts, in vitro toxicology, hazard detection and air quality monitoring to evaluate human risk. Dr. Pangburn brings 10+ years' experience in toxicology, molecular biology, cell biology and biochemistry. She received her PhD in Molecular Toxicology from the University of Colorado Health Sciences Center wherein she examined the biologic and biochemical mechanisms of the chemopreventive effects of non-steroidal anti-inflammatory drugs. Heather subsequently executed her postdoctoral fellowship in the Regenerative Medicine and Stem Cell Biology Program at the University of Colorado Denver studying genetic pathways and identifying genetic alterations that occur in acquired skin diseases such as cancer. Following her fellowship, Dr. Pangburn served as Research Scientist and Radioprotection Team Lead in the Human Signatures Branch of Air Force Research Laboratories 711th Human Performance Wing where she led a team of scientists in identifying and exploiting molecular mechanisms to provide enhanced human performance and injury protection to the warfighter in high radiation environments.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-21

HIGH PERFORMANCE COMPUTING OF QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP (QSAR) MODELS APPLIED TO TOXICOLOGY AND ADVERSE OUTCOME CELLULAR PATHWAY ANALYSIS

PROJECT SYNOPSIS: Current DoD and US Air Force human health chemical exposures require rapid response assessments of airmen training or deployed in physiologically stressful environments, while being exposed to a diverse array of chemicals of potentially toxic concern. This project seeks to leverage large global chemical and biological databases to create computational algorithms that can predict robust human health consequences in nearly real time, providing a whole new possibility to improve decision planning. The overall scientific goals of this project are to build QSAR models supported by large databases for chemicals and drugs with known response elements that will provide a more robust prediction of the major toxicological modes of action for chemicals of interest to the USAF occupational and deployed environments. High performance computing tools will be utilized to rapidly perform the necessary cheminformatics calculations for correlation with cellular level response "read-outs" necessary to construct algorithms. This will be dictated by the chemical domain space and the complexity of the response elements chosen for each Adverse Outcome Pathway (AOP) of interest.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Chemistry, Computational Chemistry, Computer Science

RESEARCH LOCATION: USAF School of Aerospace Medicine, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Heather Pangburn, PhD

DEGREE: Molecular Toxicology & Cancer Pharmacology, University of Colorado, 2007

Heather Pangburn, PhD, is a Research Toxicologist in the USAF School of Aerospace Medicine, Department of Aeromedical Research, overseeing and conducting research related to Force Health Protection to include synthetic biology and precision medicine/total exposure health efforts, in vitro toxicology, hazard detection and air quality monitoring to evaluate human risk. Dr. Pangburn brings 10+ years' experience in toxicology, molecular biology, cell biology and biochemistry. She received her PhD in Molecular Toxicology from the University of Colorado Health Sciences Center wherein she examined the biologic and biochemical mechanisms of the chemopreventive effects of non-steroidal anti-inflammatory drugs. Heather subsequently executed her postdoctoral fellowship in the Regenerative Medicine and Stem Cell Biology Program at the University of Colorado Denver studying genetic pathways and identifying genetic alterations that occur in acquired skin diseases such as cancer. Following her fellowship, Dr. Pangburn served as Research Scientist and Radioprotection Team Lead in the Human Signatures Branch of Air Force Research Laboratories 711th Human Performance Wing where she led a team of scientists in identifying and exploiting molecular mechanisms to provide enhanced human performance and injury protection to the warfighter in high radiation environments.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-22

PREDICTING PERFORMANCE DECREMENTS FROM ETHANOL EXPOSURE

PROJECT SYNOPSIS: The goal of the project is to develop a computational model that can predict cognitive performance when exposed to different levels of ethanol and caffeine. This will be achieved by integrating a physiologically-based pharmacokinetic model that provides blood concentrations to a computational cognitive model capable of performing identified tasks. You will work with a diverse team of cognitive scientists, computer scientists, toxicologists, and biomedical engineers to achieve the goals of this project. Part of the summer will require developing a literature review, with the explicit goal of submitting the review and modeling results to a relevant conference (e.g., cognitive science, Aerospace Medical Association conference, etc.).

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, / Biomedical Engineering, Cognitive Science, Computer Science

RESEARCH LOCATION: Cognitive Science, Models, and Agents, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISOR: Christopher Myers, PhD

DEGREE: Cognitive Science, Rensselaer Polytechnic University, 2007

Dr. Myers performs research in the fields of computational cognitive modeling, decision-making, interactive behavior, perception-action systems, team cognition, and autonomous synthetic teammates. He is currently a Senior Cognitive Scientist at the Air Force Research Laboratory, Cognitive Science, Models, & Agents branch.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-23

UNDIFFERENTIATED COGNITIVE AGENTS

PROJECT SYNOPSIS: The goal of the project is to develop an undifferentiated agent (uAgent) that is a set of general-purpose computational cognitive capacities enabling it to read natural language task instructions, generate the requisite task knowledge, and self-specialize to different levels of task proficiency. We will identify & integrate core cognitive capacities within a cognitive architecture that enable the move from read instructions to actionable rules and knowledge. Together we will be completing a literature review on computational models of learning from instruction and developing an agent that can perform minimally complex tasks learned from instruction (e.g., psychomotor vigilance task).

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Cognitive Science, Computer Science, Experimental Psychology

RESEARCH LOCATION: Cognitive Science, Models, and Agents, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Christopher Myers, PhD

DEGREE: Cognitive Science, Rensselaer Polytechnic University, 2007

Dr. Myers performs research in the fields of computational cognitive modeling, decision-making, interactive behavior, perception-action systems, team cognition, and autonomous synthetic teammates. He is currently a Senior Cognitive Scientist at the Air Force Research Laboratory, Cognitive Science, Models, & Agents branch.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-24

LINKING NEUROFUNCTIONAL DATA TO COGNITION TO UNDERSTAND THE VIGILANCE DECREMENT

PROJECT SYNOPSIS: Advances in computational architectures for simulating cognition have provided increasingly broad and detailed accounts of the foundational mechanisms of human information processing that support complex cognition in a variety of domains. In recent years, theories have made greater connection to neurofunctional data, like fMRI, to inform and constrain theoretical accounts. This project builds upon that research in two critical ways. First, the focus of the research is on the vigilance decrement, one of a variety of factors, called cognitive moderators that continually impact the efficiency and effectiveness of goal-directed processing. Computational models of cognitive moderators are rare, despite their relevance and importance in real-world environments. Secondly, the research will seek to link evidence from EEG data to computational models, expanding the constraints applied in developing models of human cognition. The project involves working with an existing model of the vigilance decrement, along with EEG data from a recent experiment to identify theoretical links between the proposed mechanisms and evidence from the EEG results. The goal is to develop new approaches to link EEG data to computational mechanisms to better understand the vigilance decrement, its causes, and the underlying impacts to the cognitive system that produce it.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Neural Science, Cognitive Science, Computer Science, Mathematics

RESEARCH LOCATION: Cognitive Science, Models, and Agents, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Glenn Gunzelmann, PhD

DEGREE: Cognitive Psychology, Carnegie Mellon University, 2003

Dr. Gunzelmann is a Senior Cognitive Scientist with the Human Effectiveness Directorate in the Air Force Research Laboratory (AFRL), where he serves as the Science and Technology Advisor for the Cognitive Science, Models and Agents Branch. Glenn contributes to research efforts spanning the Cognitive Science, Models, and Agents Branch portfolio, and leads research to develop computational theories that account for the impact on cognitive processing of moderators like sleep loss and vigilance to inform risk management and support real-time monitoring.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-25

UNDERSTANDING MICROBIOME FOR HUMAN PERFORMANCE AUGMENTATION

PROJECT SYNOPSIS: The 711 Human Performance Wing, Air Force Research Laboratory is building ongoing partnerships with the Navy and the Army to determine the importance of the microbiome in human health and performance. The microbiome is the collection of microorganisms that are normally associated with an individual. These microorganisms perform critical functions for the individual and an increasing number of diseases, both somatic and psychological include an altered and aberrant microbiome. In terms of numbers and diversity, the largest microbiome is associated with the gastrointestinal tract, where microbial cells reach levels of billions per milliliter. However, the microbiomes of other organs, such as the lung and skin, have been shown to be equally important to human health and performance. The Tri-Service Microbiome Consortium have embarked on multiple joint efforts to understand how the unique factors affecting deployed personnel impact their microbiomes. These include changes in diet, changes in environment, acute and chronic stress, changes in circadian rhythms, and jetlag. Microbiomes are investigated by isolating DNA from the area of interest and determining microbiome composition or metabolic potential. In this context, project would include microbiome analysis and integration of different data types.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Bioinformatics, Biochemistry, Computational Modeling, Biophysics

RESEARCH LOCATION: 711th Human Performance Wing, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Nancy Kelley-Loughnane, PhD

DEGREE: Biochemistry, Boston College University, 2000

Nancy Kelley-Loughnane, Ph.D. is the Biosciences Technical Advisor to the Chief Scientist of the 711th Human Performance Wing (711 HPW), Air Force Research Laboratory coordinates the Wing's bioscience research activities, including Air Force Science and Technology (S&T) funded research, Defense Health Program/Air Force Medical Service funded research, as well as Office of Secretary of Defense funded research for Synthetic Biology for Military Environments which involves Air Force, Army, and Navy. Nancy's current Air Force research integrates multi-disciplinary expertise in fields such as synthetic biology, microbiome, protein chemistry, molecular biology, genomics, and bioinformatics, and leads research in the development of sensors to detect markers of human performance.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-26

VISUAL EVALUATION OF EXTREME OPTICAL DISTORTION PATTERNS IN OPHTHALMIC LENSES

PROJECT SYNOPSIS: Optical distortion patterns in clear polycarbonate lenses can be induced during the molding process and can potentially become more prevalent when protective coatings are applied. Distorted areas in lenses can vary in shape and size, and can diminish or blur transmitted images reducing optical quality. The current MIL STD utilizes a qualitative approach for the determination of visual acceptability of optical samples. The goal of this project will be to perform physical characterization of extremely induced distortion per the current MIL STD, then perform the characterization with a newer technical approach to include modeling, and finally, perform a simple visual evaluation through the distortion samples using a computer based Contrast Sensitivity test to determine a contrast threshold through the sample. This data will provide a more quantitative relationship for augmenting the MIL STD with a more objective approach.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master's, Bachelor's/ Computer Sciences, Human Factors, Information Sciences

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Brenda Novar

DEGREE: Engineering Management, Drexel University, 2010

Ms. Novar is currently the Technical Manager for the Laser Protection program. She has a background in engineering and has been with the Air Force Research Lab since 2008. During this time, her research efforts have focused on the impact of broadband light and visible lasers on visual performance as well as the evaluation of laser eye protection devices. From 2012-2014, she was a Program Manager for the Directed Energy Protective Equipment program. Her research group collaborated with AFRL/RXAP to provide technical support for the 6.3 ATD Visor Laser Eye Protection program, with the goal of delivering high-quality protective equipment to the war-fighter. She is a current member of OSA, SPIE and IEEE.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-27

IMAGING AT THE SPEED OF LIGHT: UTILIZING COMPRESSED ULTRAFAST PHOTOGRAPHY TO OBSERVE FUNDAMENTAL INTRACELLULAR DYNAMICS IN REAL-TIME.

PROJECT SYNOPSIS: For many full-field imaging techniques, such as fluorescence based microscopy, imaging speeds are often limited by the read-out rate of the CCD or CMOS detector used. While advances in these technologies have allowed for faster image acquisition rates over time, fundamental physical limits in these devices prevent this technology from further increasing imaging speed. With the recent development of Compressed Ultrafast Photography (CUP), single-shot images at up to 100 billion frames per second have been demonstrated. We have incorporated CUP detection into an inverted microscope to allow for microscopic scale imaging of biological phenomena at unprecedented frame rates. In this project, we seek to further utilize CUP based imaging to greatly enhance the imaging speed of techniques such as fluorescence lifetime imaging, and to utilize this to study the effects of directed energy on the molecular level. Opportunities include laboratory based imaging experiments as well as software development to enhance image processing speeds via GPU processing.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Computer Science, Physics, Biomedical Engineering

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Joel N. Bixler**,** PhD

DEGREE: Biomedical Engineering, Texas A&M University, 2015

Joel Bixler is a Research Biomedical Engineer in the Optical Radiation Branch at the Air Force Research Laboratory Airman Systems Directorate. He joined the Air Force Research Laboratory as a Pathways intern in 2014, and currently works as a principle investigator for a seedling effort to develop ultrafast imaging systems. He is a Co-PI on a three-year Air Force Office of Scientific Research LRIR grant working to combine compressed ultrafast photography with fluorescence based imaging techniques in order to study the effects of directed energy at the molecular level. Additionally, Dr. Bixler works with the modeling, simulation, and analysis team to develop improved methods for modeling laser-tissue interaction.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-28

COMPUTATIONAL MODELING OF PILOT INJURY RISK IN EJECTION ENVIRONMENT

PROJECT SYNOPSIS: AFRL 711th HPW/RHCPT has developed human response models during vertical impacts. The models require further validation under dynamic loading events in the vertical direction. This research project focuses on correlating the response of ejection computational models in longer duration dynamic loading scenarios (50-200 msec time to peak) similar to those expected when pilots eject from an aircraft. Additional work will focus on comparing model results from our in-house test facility with human models to human subject study operational data studies conducted on the Vertical Drop Tower and Horizontal Impulse Accelerator at WPAFB.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Mechanical Engineering, Biomedical Engineering, Aerospace Engineering

RESEARCH LOCATION: Applied Neuroscience and Physiology, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Casey W. Pirnstill, PhD

DEGREE: Biomedical Engineering, Texas A&M University, 2015

Casey Pirnstill is a principle investigator for efforts focusing on physiological performance and injury potential in extreme aerospace conditions. Research includes characterization of human response injury criteria with an emphasis on cervical and lumbar spine injuries for acute and chronic exposures. Through the combination of research testing and simulation, current efforts are focused on the development and validation of advanced biofidelic injury prediction models. Dr. Pirnstill joined the Air Force Research Laboratory in 2015 as a Research Biomedical Engineer.

Repperger Research Intern Program

RESEARCH PROJECT: AFRL-RP-18-29

TASK AND MODEL DRIVEN NETWORK VISUALIZATION

PROJECT SYNOPSIS: Network data is produced in many research areas such as sociology and engineering as well as in numerous operational settings such as intelligence and cyber defense in military applications. In operational settings, it is often necessary to characterize the networks when the underlying structure is unknown, and, consequently, it is of the best interest to monitor the network once the structure is known. Researchers at the Air Force Research Laboratory's Airman Systems Directorate have demonstrated that the network visualization method that provides the best accuracy and response time in a basic network related task is dependent on the combination of the task being performed and the underlying network structure/model. Additionally, a statistical method to characterize and monitor degradation within a given network have also been developed in our lab. Research efforts are now being focused on leveraging the underlying structure of other types of network model, such as the Watts-Strogatz model, to further expand the catalog of statistically driven tools for classifying and monitoring networks. For this internship, the student would be assisting in combining these results into a network visualization tool that can provide the most insightful visualization for a given network and task by first classifying the network to the appropriate model and then utilize the best network visualization method in accordance to the characterized model and task at hand.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Computer Science, Mathematics, Statistics

RESEARCH LOCATION: Battlespace Visualization, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Fairul Mohd-Zaid, PhD

DEGREE: Applied Mathematics, Air Force Institute of Technology, 2016

Dr. Fairul Mohd-Zaid is a Mathematical Statistician at the Air Force Research Laboratory's Battlespace Visualization Branch conducting research in network analysis, network visualization, and topological data analysis with other research interests in multi-sensor image fusion and automated target recognition for images. Dr. Mohd-Zaid received the BS in Mathematics from Southern Polytechnic State University and the MS in Operations Research and PhD in Applied Mathematics from the Air Force Institute of Technology. He is also a three time recipient of the DoD funded Science, Mathematics, And Research for Transformation (SMART) scholarship.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-30

IMPACT OF SHORT PULSE ELECTROMAGNETIC FIELDS ON MAMMALIAN CELLS

PROJECT SYNOPSIS: Our laboratory's goal is to understand the biological effects of high peak power microwaves. Utilizing directly applied nanosecond pulsed electric fields (nsPEF) as a microwave surrogate; we study changes in cell plasma membrane structure, morphology and physiological, and genetic and proteomic expression. To study such changes, we use electrophysiological and optical microscope systems to record changes in membrane conductance in real time allowing for the determination of thresholds for effect of various nsPEF exposure parameters. In addition, we study the impact of such pulses on neurological cells to investigate the impact of electrical pulses on the conduction of action potentials. Genetic and proteomic techniques are used in conjunction with an exposure system capable of exposing a population of cells to elucidate stressful and lethal exposure endpoints. Lastly, we pursue the development of theoretical models that describe and predict the impact and response of cells exposed to nsPEF. We aim to generate models that compliment empirical results to predict observed cellular effects and lethality. The overarching aim of this research effort is to generate a comprehensive model that can predict the field distribution and biological impact of high peak power microwave exposures to ensure soldier safety in the battlefield.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Biomedical Engineering, Electrical Engineering, Biophysics

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Bennett L. Ibey, PhD

DEGREE: Biomedical Engineering, Texas A&M University, 2006

Dr. Ibey began working for the Air Force Research Laboratory in 2007 as the principal Investigator of high peak power microwaves (HPPM) bioeffects. His research includes the construction of HPPM microwave systems, the use of patch clamp to study cellular bio-electric effects, the development of theoretical models, cellular microscopy, and the measurement of genetic or proteomic effects of HPPM exposure. Dr. Ibey has published 1 book chapter, 5 patents, and 47 peer-reviewed publications. He is a board member of bioelectromagnetics society, active member of SPIE, and the Direct Energy Professional Society. He was named the AF Junior Civilian Scientist of the Year 2010 and received an honorable mention for the McLucas Basic Science Award in 2011.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-31

UTILIZING DIRECTED ENERGY TO MODIFY THE GASTROINTESTINAL MICROBIOME

PROJECT SYNOPSIS: The mission of the Radio Frequency Bioeffects branch is to help keep soldiers safe by investigating the biological effects from Directed Energy exposure. Ms. Martens laboratory is focused on exploring the bioeffects of high peak power microwaves on the human gastrointestinal microbiome. In recent years, strong evidence has supported the claim that fluctuations within the gut microbiome are responsible for various diseases within the human body. Our research is seeking to answer: What happens to the gut bacterial communities post exposure to directed energy? To help answer this question we look at changes in bacterial viability and in the genetic and proteomic profile of the bacteria post nanosecond pulse electric field (nsPEF) exposure, a surrogate for high peak power microwaves. In summary, we expose pathogenic and probiotic bacterial cells to nsPEF and perform various biological assays and genetic screens to assess the effect of the exposure. Additionally, due to the multi-drug resistant bacterial pandemic, we are seeking to find a novel, non-pharmaceutical, non-invasive way to treat bacterial infections via Directed Energy. To explore this concept, we also ask has bacterial sensitivity to antibiotics changed after exposure? The central goal of this research is to provide an encompassing model that can predict gastrointestinal sensitivity to Directed Energy.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Microbiology, Genetics, Biomedical Engineering
RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX
RESEARCH ADVISER: Stacey L. Martens
DEGREE: Biological Sciences, Northern Illinois University, 2014

Ms. Martens began working at the Air Force Research Laboratory (AFRL) in 2014. She joined the Radio Frequency Bioeffects branch, as a research biological scientist, to investigate the biological effects of nanosecond pulsed electric fields (nsPEF) on biological systems. As the principal investigator, she is currently focused on understanding the changes within the gastrointestinal microbiome following nsPEF exposure. The long term goal of this work is to increase human performance by modulation of the gut microbiome and ensure the safety of military personnel. Before joining AFRL, Ms. Martens served as a Research Assistant at Northern Illinois University pursuing a Master's Degree in Microbiology. The focus of her research was to determine the role of regulatory genes controlling mycotoxin production in *Aspergillus nidulans*. She also collaborated with the United States Department of Agriculture to determine the role of two separate gene clusters and their association with morphological development and secondary metabolism in *Aspergillus flavus*. Ms. Martens has been in the field of Biological Sciences for 5 years and has authored/co-authored 5 peer reviewed scientific journal publications and has 1 patent pending. Additionally, she has won several awards at Northern Illinois University and AFRL for her contributions to genetics and nsPEF projects.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-32

INVESTIGATION OF NOVEL SIGNALING ELEMENTS FOR NON-TRADITIONAL OPTOGENETIC APPROACHES

PROJECT SYNOPSIS: Recent development of light-controlled cellular activity, known as optogenetics, has sparked interest in new methods for light-induced neural and cellular activation. To date, the majority of optogenetics research is performed through transfection of opsins into neurons to control activity, and brain stimulation is conducted through thin fibers inserted directly into the skull of small mammals. Although optogenetics is a useful tool, there are still limitations, and as a result, novel alternatives are desired. To overcome these limitations, we are interested in the use of non-traditional electromagnetic (EM) frequencies in order to move towards a non-invasive optogenetic approach. Specifically, our group focuses on both the molecular mechanisms as well as whole cell models, for the development of new, protein-based sensing elements. Molecular simulations, coupled with ultrafast spectroscopic techniques, will be performed in order to validate the engineered proteins as well as provide novel capabilities to AFRL.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's/ Chemistry, Biochemistry, Spectroscopy

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Morgan S. Schmidt, Phd

DEGREE: Chemistry/Spectroscopy, University of Denver, 2012

Dr. Morgan Schmidt joined the U.S. Air Force Research Laboratory (711th HPW/RHDR) in 2016, after working for AFRL as an ORISE and NRC postdoc. Her doctoral research was completed in Chemistry, where she investigated plasma spectroscopic techniques applied to biological and environmental matrices using both laser-induced breakdown spectroscopy (LIBS) and spark-induced breakdown spectroscopy (SIBS). Current efforts are focused on developing new, ultrafast optical techniques such as multidimensional infrared spectroscopy, to investigate novel alternatives to traditional optogenetics through the design of unique, protein-based sensing elements.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-33

RADIO-SENSITIZING EFFECTS OF NON-IONIZING DIRECTED ENERGY

PROJECT SYNOPSIS: In today's modern battlefield the use of both ionizing and non-ionizing directed energy sources will likely overlap leading to complex biological interactions in exposed personnel. The bioeffects as well as health risks associated with both ionizing and non-ionizing radiation are well known, however little data exists on the combined effects of these radiations. In this project, we will assay the radio-sensitizing effects of short duration pulses delivered to cells grown in vitro. We will used a variety to techniques such as flow cytometry, MTT, and confocal microscopy to assay cell viability. Other techniques such as comet assay, clonogenic assay, Real Time qRT-PCR, and Western blot will be used to determine the genetic health of exposed samples. This work is vital to understanding the synergistic effects of two complicated directed energy interactions.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/ Biomedical Engineering, Biology, Biophysics

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Caleb C. Roth, PhD

DEGREE: Radiation Biophysics, University of Texas Health Service Center, 2016

Dr. Roth is a research scientist in the Air Force Research Laboratory's Radio Frequency Bioeffects Branch. Dr. Roth began work at the United States Air Force Research Laboratory, Radio Frequency Bioeffects Branch at Brooks City-Base in 2004 as a Research Scientist for General Dynamics AIS. In 2012, Dr. Roth was awarded the SMART Scholarship (The Science, Mathematics and Research for Transformation Scholarship for Service Program). Dr. Roth received his Ph.D. degree in Radiation Biophysics from University of Texas Health Science Center San Antonio in 2016. Dr. Roth conducts active research in many projects, including RF bioeffects/dosimetry, small animal imaging, the use of photoacoustic techniques (probe beam deflection) to study cellular/biophysical effects associated with short duration electrical pulses, advanced cellular microscopy, and the measurement of genetic or proteomic effects of HPPM and electric pulse exposure. Dr. Roth has published >25 peer-reviewed publications, and >28 conference proceedings. He is an adjunct professor at UTHSCSA in the department of Radiological Sciences and is a member of the Radiation Biology Graduate Track Committee.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-34

NON-INVASIVE VOLUMETRIC THERMAL DOSIMETRY UTILIZING OPTICALLY GENERATED ULTRASOUND

PROJECT SYNOPSIS: Biological responses to directed energy, specifically radio frequency (RF) based stimulus, occur on short time scales often deep in tissue where direct measurement of the driving mechanisms is non-trivial. RF induced bioeffects are often linked to the thermal response of the exposed tissue. A non-invasive volumetric thermal dosimeter is necessary to calculate the received thermal dose and characterize the resulting biological response. An ultrasound based thermal imaging system utilizing optical ultrasound generation and sensing that can be implemented during high power RF exposure is desired. Research projects should be focused on one of the following objectives: 1. Design/Improve implementation geometry for an all-optical ultrasound based thermal dosimetry system, 2. Develop a novel reconstruction algorithm utilizing probe beam deflection (PBDT) as a sensing mechanism. 3. Test ultrasound system/reconstruction algorithm in high power RF exposure scenarios.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/Electrical Engineering, Computer Science, Biomedical Engineering

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Ronald Barnes, PhD

DEGREE: Electrical Engineering, University of Texas at San Antonio, 2014

Dr. Barnes is a research electrical engineer for the Air Force Research Laboratory (AFRL), 711 Human Performance Wing, Bioeffect Division, Radio frequency bioeffects branch in Fort Sam Houston Texas. His doctoral research involved development of novel optical sensors for photoacoustic and ultrasound imaging. He began working at AFRL in 2014 as a Repperger Intern and subsequently a National Research Council Postdoctoral Fellow. He is currently a principal investigator for novel directed energy (DE) dosimetry techniques. Additionally, Dr. Barnes utilizes finite element modelling to analyze multi-physics problem sets pertaining to DE applications. Before joining AFRL Dr. Barnes spent time in small business startups specializing in full stack development and prototype generation.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-35

RISK ASSESSMENT AND BIOEFFECTS OF VERY HIGH FLUX ELECTRON BEAMS

PROJECT SYNOPSIS: This project will develop risk assessments for military use of very high flux/high energy electron beams. The project will involve modeling of dose from in field and out-of-field electron beam exposure, measurement of electron beam parameters, prediction of bioeffects, and verification of bioeffects with and animal study of direct exposure. The student will be involved with modeling, phantom selection, dosimetry, and planning for the animal experiment. BACKGROUND: Electron beams have been used in industrial and medical applications for a number of years so tools exist to assess dose and risk from those devices. However, higher flux and energy electron beams may produce unexpected levels of dose, risk, and bioeffects. This project will look to developing methodologies for assessing dose, risk, and bioeffects for higher flux and energy devices.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, /Health Physics, Medical Physics, Nuclear Engineering

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Noel D. Montgomery, PhD

DEGREE: Biomedical Engineering, University of Texas at San Antonio, 2016

Dr. Montgomery is a Diplomate of the American Board of Health Physics (1995). His main research interests are modeling and measurement of interaction of radio frequency (RF) and ionizing radiation with tissue, dosimetry, and health consequences of exposure. After a 21 year Air Force career as a Health Physicist, Dr. Montgomery returned to school on the Air Force Long Term Full Time Training program where he earned a PhD in Biomedical Engineering with a dissertation titled: Model of Electric Conductivity of White Matter using Magnetic Resonance Imaging Data. His previous work included dose and risk assessments on a variety of ioninizing and nonizing systems.

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: AFRL-RP-18-36

BIOLOGICAL EFFECTS ASSOCIATED WITH TERAHERTZ RADIATION

PROJECT SYNOPSIS: Over the past few years, Terahertz (THz) radiation sources and detectors have advanced greatly driving more use of THz-based technologies in many military and civilian operations, such as in wireless communication, security and defense, and in spectroscopy and imaging. The emergence of these new THz systems has opened the door for numerous exciting applications, but the introduction of these new systems has also prompted safety concerns and has stimulated much interest and activity among the THz bioeffects community. The mission of AFRL's Radio Frequency Radiation Branch is to understand the fundamental effects of exposure to THz radiation not only to support the development of exposure standards to ensure the safety of our military personnel, but also to identify areas ripe for exploitation. Specifically, we seek to provide a scientific basis to answer the following questions: (1) What are the exact biophysical and biochemical mechanisms that govern THz interactions with biological structures? (2) Can these mechanisms be exploited for selective non-contact stimulation and control of biological activity? Our current work investigates the effect of THz frequencies on cells. We examine changes in gene expression and epigenetic patterns, and the downstream effects on cellular bioenergetics, intracellular signaling, cellular damage, and survival.

STUDENT LEVEL / DISCIPLINE NEEDED:
PhD, Master's, Bachelor's/Biomedical Engineering, Biology, Physics

RESEARCH LOCATION: Radio Frequency Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Ibtissam Echchgadda, PhD

DEGREE: Cellular and Structural Biology, University of Texas HSC San Antonio, 2003

Dr. Ibtissam Echchgadda is a Research Biological Scientist for the Air Force Research Laboratory (AFRL), 711 Human Performance Wing, Bioeffects Division, Radio Frequency Bioeffects Branch, Fort Sam Houston, TX. Her current research focuses on investigating the biophysical and biochemical mechanisms that govern Radiofrequency electromagnetic fields interaction with biological systems. Dr. Echchgadda has over 15 years of experience in different basic science and applied research. Before joining AFRL, she worked as a defense contractor for General Dynamics and before that she served as a Research Faculty at the University of Texas Health Science Center San Antonio. Dr. Echchgadda received multiple honorable awards and her work has been published in high-impact journals.