

Innovate Locally | Transform Globally

The Research Seed Funding Program (RSFP) was an evolution of the Multidisciplinary Seed Funding Program. Active during the 2014-15 school year, awards totaled nearly \$190,000, spread across five research teams of ODU and collaborators from other institutions. For information on the current ODU Intramural Funding programs, please visit <http://odu.edu/facultystaff/research/funding/opportunities/intramural-funding>.

Unless otherwise noted, the investigators named below are from ODU and are identified by the departments and/or centers they represent.

“Build and Test a New Automated Particle Collector for the Deep Sea”

Alexander B. Bochdansky - Associate Professor – Ocean, Earth and Atmospheric Sciences (PI)

Rodney J. Johnson – Assistant Research Scientist - Bermuda Institute of Ocean Sciences (Co-PI)

Abstract

Seed-funding is sought to build and test a new device that collects macroscopic particles in deep-sea environments. It is a response to new initiatives by NASA and NSF to better understand sinking fluxes and the transformation of particles in the deep ocean. Biological processes (activity of microbes and zooplankton) have a large influence on modulating the amount of carbon removed from the atmosphere and on the transport of carbon to the deep sea. We propose to convert an early prototype into a deep-sea version that we will test in the field, and use to create preliminary data for inclusion into grant applications. This new device will provide an unbiased collection of macroscopic particles in the deep sea so that we can compare them to conventional Niskin bottle samplers, the ambient water surrounding the particles, and particles collected in standard sediment traps. Included in this request is funding for travel, and to ship material to Bermuda to test the new device on a research vessel made available to us by the Bermuda Atlantic Time-series Study (BATS) and Hydrostation S programs. The goal of this seed-funding project is to provide compelling proof of concept to convince both NSF and NASA EXPORTS to commit funds for the construction of more of these instruments, deploy them globally, and to fund new scientific projects that are built around this unique sampling strategy.

“Machine Learning Methods for Micro-Scale Brain Map Reconstruction”

Shuiwang Ji – Assistant Professor - Department of Computer Science (PI)

Dinggang Shen – Professor of Radiology - University of North Carolina School of Medicine (Co-PI)

Abstract

Following the BRAIN Initiative in 2013, investigations into how the brain functions in health and disease is gaining increasing momentum. Reconstruction of brain map at the micro-scale using electron microscopy (EM) data is considered to be a top priority in the NIH BRAIN Working Group Report [4]. With the increasing availability of brain EM data, the bottleneck lies in the computational reconstruction of brain maps using machine learning and artificial intelligence tools [4]. In this project, we propose to employ advanced machine learning methods known as “deep convolutional neural networks” for brain map reconstruction. To improve the model accuracy and reduce the cost of manually generating ground truth data, we propose to employ (1) transfer learning methods for knowledge transfer from natural image data sets, and (2) active learning methods for identifying the most informative samples for manual annotation.

“A Modified External Aiming Device (MEAD) for Portable X-Ray Equipment: An Innovative Solution for Victim Identification, Forensic Dentistry, and Mobile Dentistry/Dental Hygiene”

Tara L. Newcomb - Assistant Professor - School of Dental Hygiene (PI)

Ann M. Bruhn - Assistant Professor - School of Dental Hygiene (Co-PI)

Bridget Giles - Research Assistant Professor - Virginia Modeling, Analysis and Simulation Center (Co-PI)

Hector M. Garcia - Senior Project Scientist - Virginia Modeling, Analysis and Simulation Center (Co-PI) Kathryn Simms - Research Associate - Office of the Dean, College of Health Sciences (Co-PI)

Steven M. Becker - Professor - Community and Environmental Health (Co-PI)

Abstract

Dental X-rays are generally considered to be one of the best techniques for victim identification; however, this approach has challenges that typically go unrecognized outside of the fields of dentistry and dental hygiene. Simply put, X-ray equipment and auxiliary equipment are constructed for use on the living, and, thus, have structural incompatibilities for use on the dead. These incompatibilities dramatically increase the odds of failing to image the teeth of interest, and to achieve proper angulations that are required to make comparisons for victim identification. Consequently, our team is developing

"MEAD"- A Modified External Aiming Device- as a remedy. This technology has multiple applications and potential markets (e.g., Mass Facility Incidents [MFIs], General Victim Identification, and Mobile Dentistry/Dental Hygiene).

Our goal is to evaluate MEAD for the purpose of obtaining data for refining its development- thus, assisting us with its transition to the market place.

Additionally, given the competitiveness of the external funding market, this project will greatly improve our odds of obtaining the external grant funding opportunities identified in this proposal. More specifically, we will compare the performances of a non-

disposable version of MEAD, a disposable version of MEAD, and a traditional external aiming device. Measures evaluated will include the quality of dental X-rays produced, efficiency, and expert hygienists' assessment of each device.

“High-Performance Particle Collider Simulations on Parallel Computing Platforms”

Balša Terzić – Assistant Professor - Department of Physics and the Center for Accelerator Science (PI)

Alexander Godunov – Associate Professor- Department of Physics and the Center for Accelerator Science (Co-PI)

Desh Ranjan – Professor & Chair - Department of Computer Science (Co-PI) Mohammad Zubair - Professor - Department of Computer Science (Co-PI)

Abstract

Understanding the fundamental structure of matter in the physical universe is one of the central goals of scientific research. Particle colliders are essential tools for reaching this goal. In circular colliders, two counter-rotating beams, each consisting of hundreds of billions of particles travelling at nearly the speed of light, are forced to collide at each turn. These collisions happen millions of times per second. Operating a collider costs hundreds of thousands of dollars per hour. By using high-fidelity simulations to capture the underlying physics will not only defray the operation cost but also contribute to fine-tuning the collider parameters for more efficient operation. These simulations are very time-consuming on a single-processor system (on the order of months) and need to be implemented on the massively parallel computer architectures to reduce the simulation time to reasonable values (on the order of days).

The goal of this project is to lay the groundwork for developing a strong proposal in the area of large-scale, efficient and physically faithful simulations of the existing and next-generation particle colliders. Ultimately, the computational methodology we propose to advance will lead to substantial savings in design and operation of these expensive machines.

Our long-term goal for the new computational approach is to become a standard tool for the design and optimization of the existing and future high-energy and nuclear physics facilities. It will allow a direct validation of a collider's design, providing confidence in the project's success and making its construction or upgrade more likely. Our new suite of computer codes will offer optimization paths not available with existing tools for enhancing the performance of these facilities. It may even be possible to provide a system for the accelerator control room, capable of near-real-time simulations to assist the tuning of the machine. All of these capabilities will lead to substantial cost savings.

“Collaborative Research: Development of Super-Resolution and Real-Time Optical Nanoscopy for Biomedical Research”

X. Nancy Xu - Professor in Chemistry and Biochemistry (PI)

Khan M. Iftekharuddin – Professor & Director of Vision Lab - Department of Electrical and Computer Engineering (Co-PI)

Abstract

Fluorescence-based imaging tools are primary workhorses for live cell imaging. Unfortunately, they require shorter wavelength excitation sources (lasers), which lead to autofluorescence and phototoxicity of live cells. Multiple excitation sources are required to excite multicolored fluorophors for multiplexing detection of multiple analytes and biomarkers, which lead to complex and expensive instrumentation, and they are often limited by spectral resolution. Typically, it cannot image more than 3 colors of fluorophors simultaneously. These technology limitations prohibit us from fully understanding cellular functions in real-time at molecular resolution and prevent full understanding of onset and development of diseases (e.g., cancer) and design of effective diagnosis and therapy.

The Xu research group has been developing a novel imaging platform, including next-generation multicolored far-field photostable optical nanoscopy (PHOTON) with photostable multicolored single molecule nanoparticle optical biosensors (SMNOBS), that can quantitatively image and molecularly characterize roles and functions of multiple types of molecules at individual live cells in real time at nanometer (nm) resolution. They have demonstrated that PHOTON can be used for a wide variety of biomedical applications, including identification and characterization of rare subsets of single cancer stem cells in heterogeneous tumor cells for design of effective diagnosis and therapy by mapping single receptors (protein biomarkers) of cancer stem cells.

Current imaging reconstruction methods are very time consuming, and take months to analyze experimental imaging data. The Co-PI (Dr. Khan M. Ifttekharuddin) is an expert in medical image analysis and reconstruction of tissue and organ images with expertise in live cell imaging, moving from macro- scale down to micro and nanometer scale imaging . This collaborative research has the potential for ground-breaking new technologies that can advance our understanding of cellular biology at the single- molecule addressing a wide range of biomedical problems, ranging from early cancer detection to the study of brain function.