HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY-SERVING INSTITUTIONS CAPABILITIES FORM

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Background of Institution (word Count 500)

NCCU is the nations's first state-supported public liberal arts college founded for African Americans, it is part of the University of North Carolina (UNC) system. Through its long history, dating from 1910, its mission has been to offer a strong and challenging educational environment that prepares students to ”advance the consciousness of social responsibility in a diverse, global society”. The university continues to demonstrate a “strong commitment to academic excellence in a diverse educational and cultural environment” by prioritizing the development of innovative, high quality academic and research programs across the sciences, including such recent, large-scale initiatives as the creation of the Biomedical/Biotechnology Research Institute (BBRI) and the Biomanufacturing Research Institute & Technology Enterprise (BRITE) Center of Excellence, which serve to address the research and training needs of underserved minority groups in the health science and biotechnology industries, respectively.

Also indicative of the NCCU vision for research infrastructure improvement is the creation of the $40M Townes Science Complex, completed in 2005 as a home for the multiple disciplines represented by the NCCU College of Arts and Science. This complex has already begun to promote a new level of excellence in education and research at NCCU by providing students and faculty immediate access to colleagues across the disciplines, as well as to world-class equipment and state-of-the art research and education laboratories, making it an ideal home for the highly technical and interdisciplinary work of NSF Center of Research Excellence in Science and Technology (CREST), NASA University Research Center, and NSF Partnership in Research in Engineering and Material Science (NSF-PREM) Centers.

The current NCCU student enrolment is 8,604 students (77% black, 11% Caucasians, 2% Hispanic, 1% Asian, 1% American Indian, 1% international, 4% unknown and 2% multiracial, 90% in-state residents, 67% female), providing a valuable opportunity for recruiting students of traditionally underrepresented race and/or gender to the sciences. NCCU has capitalized on this opportunity, establishing itself as a top institution of baccalaureate origin for science doctorate recipients who are African-American U.S. citizens. (NSF/SRS Survey of Earned Doctorates,1991-95). The University is also a frontrunner among historically black colleges in the recruitment of National Achievement Scholars, some of America’s best and brightest

students. Over the last 9 years, NCCU has graduated on average 70 undergraduate and 15 graduate students per year in the fields of Biology, Computer Science, Chemistry, Earth Science, Mathematics, and Physics; 30% of the undergraduates are admitted to graduate school. Students represent the backbone of the research enterprise at NCCU and this instrument will play a significant part in enhancing their potential skills upon graduation and in ensuring that NCCU students are competitive as they pursue advanced degrees in chemistry and physics. During the last 10 years, enormous experimental infrastructure that facilitates research has been built. Around the state of art research laboratories strong and productive research programs are established in material science, nanotechnology, renewable energies, low and medium energy nuclear and hypernuclear physics, astrophysics, geophysics, earth and environmental sciences, robotics, computer sciences, genomics, chemistry, and biology.

Physics and Engineering (word Count 500)

Physics Department faculty have made important scientific, technological and educational advances through support from the NASA, National Science Foundation, and other federal agencies. NSF-CREST center at NCCU largely supports computational, while NASA URC center supports experimental programs focused on development of NASA-relevant devices. Both centers have enabled the development of the experimental infrastructure, including a class 1000 cleanroom, 2 MeV electron accelerator with picosecond pulsed beam, a field emission scanning electron microscope and micro beam analysis system, a four-laser Raman-AFM system, UHV pulsed laser deposition system, Hall Effect and Deep Level Transient Absorption Spectroscopy systems for device characterization, 100 GHz backwards wave oscillator system, mask aligner for photolithography, growth systems for graphene and semiconductor nanowires, a photoelectron emission microscopy system that includes a gas source molecular beam epitaxy system designed for III-nitrides, NMR, FTIR, and a 256 processor supercomputer.

Physics Department develops and exploits a unique combination of theory and experimental capabilities to control structure, and discovers new phenomena at nuclear, atomic, and nano- to meso-scales, with >650 publications & 7 patents. The 8 tenured faculty, 10 research faulty, and 6 postdoctorates are collaborating on the following main research projects:

- Development of the world most intense low energy positron beam for material characterization and new generation of fundamental experiments, in collaboration with Jefferson National Laboratory
-Development of high energy (100 MeV to 10 GeV) linearly polarized photon polarimeter for astrophysical space exploration
- Production and characterization of thin films and nanostructures, quantum dots, nanowires, and carbon nanotubes and their applications in photovoltaics, quantum computing, detectors, and sensors.
- Charge transport in individual and coupled semiconductor nanostructures and charge transport using time-resolved microwave, millimeter-wave, and terahertz probe signals
- Plasmonic materials for optical filter and sensor applications
- Functionalized 2D materials for spintronic and electronic applications
- Controlling the properties of nanoscale patterned ferroics and discovery of new multiferroic

materials through epitaxial strain control of complex oxide thin films with coupled spin, charge and lattice order.
- Development of perovskite based multiferroic materials
- Smiconductor and nano ceramics research on development of high efficiency solar cells.
- Development of IR sensors and biochemical detectors based on nanostructures and quantum confinement
- Theoretical work and computer simulations of optoelectrical properties of nanostructures, charge transport and charge tunneling between nanostructures.
- Study of defects in materials and radiation damage and radiation hardens of material.
- Nuclear and hypernuclear low energy and medium energy experimental and theoretical research and development of charge particle detectors and neutrino detectors
- Rigorous few body calculations in nuclear and hypernuclear physics and their applications in nuclear astrophysics
- Fundamental studies in cosmology, alternative models for inflation, and explaining large structures in universe
- Earthquake wave propagation and study of the crustal structure in the East Tennessee Seismic Zone and a new seismotectonic model
- Study Water Vapor Continuum Absorption in Microwave Frequency Range from 10 to 300 GHz and study dielectric properties of water and sea ice.
- Comprehensive surface to mid stratospheric humidity profile combining satellite microwave sounder retrieval

Mathematics and computer science (word Count 500)

Research interests in robotics, computer vision and networking are focused on formulatation, design and development of algorithms that can facilitate improved (i) multiple robot localization, (ii) energy-efficiency and quality of service in heterogeneous robotics wireless networks, and (iii) action and human recognition in computer vision. We explore multi-robot/sensor localization, mapping and navigation, coordination of movement, design of collective behaviors for such tasks as large area exploration and data gathering, surveillance, autonomous ground, aerial and marine exploration vehicles, design and analysis of algorithms to implement and perform simulations for performance evaluation.

We are developing a Sonar Sensor Model for Underwater Terrain Mapping utilizing a novel approach for building the occupancy grid map using sonar data;

In Face Recognition, we explore a Deep Learning Based Cross-modal Face Recognition to develop a novel algorithm to match thermal face images to the data sets containing visible light face images. In this work, convolutional neural networks (CNNs) are trained to extract and integrate face features shared by both modalities;

Robust iris segmentation is essential for non-cooperative iris recognition. We explore Iris Segmentation in Visible Wavelength Images using Recurrent CNNs . Compared with near infrared eye images, iris regions in visible wavelength images often contain more noise such as environment reflections and cast shadows. We propose a novel iris segmentation algorithm for noisy visible wavelength images.

Fusion Of Color Images And Lidar Data For Lane Classification - Lane classification is a fundamental problem for autonomous driving and map-aided localization. Many existing algorithms rely on special designed 1D or 2D filters to extract features of lane markings from either color images or LiDAR data. These handcrafted features are not be robust under various driving and lighting conditions. We propose a novel algorithm to fuse color images and LiDAR data together.
Understanding Visual Attention in Unconstrained Environments; we outline a plan for understanding visual attention in unconstrained environments. Visual attention is a fundamental ability of an individual to process information. The central research problem we address is how to measure and analyze visual attention in a large three-dimensional space. The technologies have a great potential to benefit many areas, such as aviation simulation in various flight environments and coordination of visual attention for children with autism spectrum disorder.

In Cybersecurity projects, we explore Internet of Things (IoT) Mobile Cloud Security and Privacy and Vehicular Adhoc Network (VANET) Security and Privacy (active) to explore security and privacy issues of a new environment and provide efficient solutions and remedies using mathematical tools such as algorithms and applied cryptography;

in Mobile Sensor Networking and Cyber Physical Systems: to improve efficiency of networked robotics systems used in many applications, it is important to organize them according to their mission. The delay in these system is mainly due to the relative speed of the mobile agents. It is important to decide their trajectories to minimize such a delay. This project studies the near-optimal trajectories of the mobile agents with the goal of minimizing the latency caused by them for various mission.

Chemistry (word Count 500)

Research in the department is divided primarily along two areas: materials chemistry and biochemistry.

In materials chemistry, one group of faculty led by Prof. Vinodgopal is pursuing

(A) the covalent functionalization of graphene via synthetic organometallic chemistry using transition metal carbonyls and their arene derivatives in zero-valent oxidation states. The objective is twofold: a) introducing spin functionality to the graphene and b) creating reproducible and controllable band gaps in the normally “metallic” graphene”.

B) the development of nanostructured carbon electrodes for direct methanol and hydrogen fuel cells.

In addition to working on the covalent functionalization of grpahene, Dr. Sendlinger, the inorganic chemist synthesizes and characterizes main group and transition metal complexes with perfluorinated acetylacetonate ligands and both computational and experimental nuclear magnetic resonance spectra (proton, carbon-13 and fluorine-19) of these compounds.

Another group led by Dr. Darlene Taylor focuses on soft matter such as polymers for drug delivery and novel phthalocyanine based polymers for solar energy applications.

Another group led by Dr. Fei Yan is trying to develop

(1) a unique approach using surface-enhanced Raman scattering (SERS) for quantifying the labile iron pool in different subcellular compartments of living cells.

(2) Plasmonic materials for optical filter and sensor applications, They are investigating several different approaches to synthesize anisotropic gold nanoparticles with tunable surface plasmon resonance (SPR) properties , and further assemble them into two- or three-dimensional structures to develop surface-enhanced Raman assays.

The biochemistry group consist of Dr. Somnath Mulhopadhyay, Dr. Nate Wymer and Dr. Tonya Gerald. r. Dr. Mulhopadhyay focuses on cannabinoid receptors for application in prostate cancer research , while Dr. Wymer develops novel biochemical ways to develop vaccines.