

**Forward Thinking Poster Session/Colloquy Presentation
Past Award Recipients**

2016

Cancer-Related Fatigue, Mitochondrial Function, and Exercise in Cancer Survivors.

Alexander Ng, Associate Professor, Physical Therapy/Exercise Science
Aidan Flanagan

Using a Dual Viral Approach to Evaluate Stress-Induced Drug Seeking.

John Mantsch, Professor, Biomedical Sciences
Michael Nordness

Biosolids Reuse: Continuous Flow-Through Column Testing of Biosolids-Derived Biochar to Sorb Micropollutants

Patrick McNamara, Assistant Professor, Civil, Construction and Environmental Engineering
Brooke Mayer, Assistant Professor, Civil, Construction and Environmental Engineering
Lee Kimbell

Social Innovation Awards:

A Mobile Method for Determining Access Ratings for the Built Environment

Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics, and Computer Science
Drew Williams
Amit Kumar Saha

The Mediating Effects of Perceived Social Support and Positive Thinking on the Relationship

Abir Bekhet
Denis Matel-Anderson

2015

An Intersectional Investigation of Minority Stress Theory

Ed de St. Aubin, Associate Professor, Psychology
Lauren Yadlosky

mHealth System for Patients with Arthritis

Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science
Taskina Fayezeen, Md Osman Gani

Improving Services to the Hispanic Community through Technology-Enhanced Pronunciation Training of L2 Spanish-Speaking SLPs

Steven Long, Associate Professor, Speech Pathology and Audiology
Sonia Barnes, Assistant Professor, Foreign Languages and Literatures
Jeffrey Berry, Associate Professor, Speech Pathology and Audiology
Julissa Bello-Almazan, Mahala Berry

Social Innovation Award:

Monitoring Learning Capability in Autistic Populations Using Sensors

Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science
Amy Van Hecke, Associate Professor, Psychology
Niharika Jain, Piyush Saxena

2014

The Role of Biocides in Antibiotic Resistance in Wastewater Treatment

Dr. Patrick McNamara, Assistant Professor, Civil, Construction and Environmental Engineering,

Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering,
Daniel Carey

Removal of Environmental Estrogenic Micropollutants from Wastewater Solids

Dr. Patrick McNamara, Assistant Professor, Civil, Construction and Environmental Engineering,
Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering,
Thomas Hoffman

Resilience in Adolescents Who Survived a Suicide Attempt from the Perspective of the Registered Nurse in a Psychiatric Facility

Dr. Abir Bekhet, Assistant Professor, College of Nursing,
Denise Matel-Anderson

2013

Recovering from Foreclosure: An Experimental Study of a Community Outreach Campaign

Dr. Amber Wichowsky, Assistant Professor, Political Science,
Colleen Ross, Anabelle Martinez, members of POSC 4281

Anaerobic Membrane Bioreactor for Sustainable Wastewater Treatment

Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering, Matt Seib

Sensorimotor Adaptation of Connected Speech using Multiple Acoustic Cues

Dr. Jeff Berry, Assistant Professor, Speech Pathology and Audiology; Dr. Michael T. Johnson, Professor, Electrical and Computer Engineering, Brittany Bernal

2012

Porting XINU to Raspberry Pi

Dr. Dennis Brylow, Associate Professor, Mathematics, Statistics and Computer Science, Matthew Bajzek, Farzeen Harunani, and Tyler Much

Neural Responses to Social Skills Intervention in Adolescents on the Autism Spectrum: An Extension of the PEERS Research Project

Dr. Amy Vaughn Van Hecke, Assistant Professor, Psychology and Sheryl Stevens

Case Study of the Implementation of the Co-principalship in a K-8 School District

Dr. Ellen Eckman, Associate Professor, Educational Policy and Leadership and Amy Porter

2011

Legal and Extra-Legal Factors Impacting Domestic Violence Injunctions in Milwaukee

Dr. Heather Hlavka, Assistant Professor, Social and Cultural Sciences; Dr. Sameena Mulla, Assistant Professor, Social and Cultural Sciences, Kate Hanson, and Chelsea Pierski

The Human Powered Nebulizer in the Treatment of Airway Diseases in El Salvador

Dr. Lars E. Olson, Associate Professor, Biomedical Engineering; Dr. M. Therese Lysaught, Associate Professor, Theology; Christopher Hallberg, Clinical Trial Coordinator; Ellen Hawkinson, Katelynn Kramer, Brian Laning, Sarah Schmiedel, and Andrew Weingart

Parent and Family Outcomes of PEERS: A Social Skills Intervention for Adolescents with Autism Spectrum Disorders

Dr. Amy Vaughn Van Hecke, Assistant Professor, Psychology, and Jeffrey Karst

2010

The Amader Gram Breast Care Palliation Study: Phase 1

Dr. Sheikh Iqbal Ahamed, Associate Professor, Mathematics, Statistics and Computer Science, Ferdous Kawsar, Mohammad Tanviruzzaman, Md. Munirul Haque, and Mohammad Adibuzzaman

Speech Adaptation for Rehabilitation

Dr. Jeffrey J. Berry, Assistant Professor, Speech Pathology and Audiology and Mary Bolgert

The Halo Effect of Faith Communities: An Exploratory Study on Crime and Religious Social Capital

Dr. Noreen E. Lephardt, Adjunct Assistant Professor, Economics and Brenden Mason

Role of Mechanical Stress in LPS-Induced Damage of Periodontal Cells in Vitro

Dr. Dawei Liu, Assistant Professor, Orthodontics and Yaroslav Yarmolyuk, DDS

2009

The Influence of Cultural Variables on Latino/a Adolescent Sexual Activity

Dr. Lisa Edwards, Assistant Professor, Counselor Education and Counseling Psychology, Brittany N. Barber and Keyona Jarrett

Effects of Mechanical Vibration on Orthodontic Tooth Movement

Dr. Dawei Liu, Assistant Professor, Orthodontics and Andrew Rummel

Pre-service Elementary Teachers' Knowledge of Relational Thinking

Dr. Marta Magiera, Assistant Professor, Mathematics, Statistics, and Computer Science; Dr. John Moyer, Professor, Mathematics, Statistics, and Computer Science; Dr. Leigh van den Kieboom, Assistant Professor, Educational Policy and Leadership, Ashley Zenisek and Edwin O'Sullivan

2008

Role of Endurance Exercise Training in Protection of Ischemic Heart Disease

Dr. Robert Fitts, Professor and Chair, Biological Sciences, Ms. Patricia Colloton, Research Associate, and Brooke Rogers

Contribution of the Frontal Lobes to "Successful Aging"

Dr. Kristy A. Nielson, Associate Professor and Chair, Psychology, and Andrew Newsom

Novel Properties of Bean Root Nodules Harboring a Bacterial Respiratory Mutant and What These Properties May Reveal about Oxygen-triggered Regulation of the Symbiosis

Dr. Dale Noel, Professor, Biological Sciences, and Robert Stone

What's the Best Rehabilitation Prescription? Identifying Factors that Enhance Recovery of Gait after Stroke

Dr. Sheila Schindler-Ivens, Assistant Professor, Physical Therapy, and Shannon Knoblauch

2007

A Pilot Study to Develop a Behavioral Intervention to Support Self-regulated Pushing during Second Stage Labor: A Focus Group of Certified Nurse-Midwives as Informants

Dr. Lisa Hanson, Associate Professor, Nursing, and Kathryn Osborne

Mold Detection using Acoustic Wave Sensors

Dr. Fabien Josse, Professor, Electrical and Computer Engineering; Dr. Susan Schneider, Associate Professor, Electrical and Computer Engineering, and Meetalee Dalal

Father Involvement in Caring for Adolescents with Diabetes: An Investigation Piloting New Techniques in Pediatric Research

Dr. Astrida Kaugars, Assistant Professor, Psychology, and Christopher J. Fitzgerald

2006

Mentoring and Collaboration: Undergraduate, Graduate and Professional Research in Literature and Law

Dr. Christine L. Krueger, Associate Professor & Director of Core Curriculum, English, and Colleen Willenbring and Kaye Wierzbicki

Role of CamKinase Alpha in Renewal and Reinstatement of Fear

Dr. Matthew J. Sanders, Assistant Professor, Psychology, and Jocelyn Miller

Imaging of the Human Brain during Pedaling

Dr. Sheila Schindler-Ivens, Assistant Professor, Physical Therapy, and Jay Mehta

2005

Cross-Cultural Development and Testing of the Risk Information Seeking and Processing (RISP) Model

Robert J. Griffin, Professor, Journalism, Franziska Borner, Jan Gutteling, Associate Professor and Ellen Ter Huurne, doctoral student, University of Twente, The Netherlands

Neurotoxicity of BMAA in Cortical Cultures

Doug C. Lobner, Associate Professor, Biomedical Sciences, and Peachy Mae T. Piana

Sexism and Rape Myth Acceptance: A System Justification Perspective

Debra L. Oswald, Assistant Professor, Psychology, and Kristine Chapleau

**Marquette International Research Poster Session
Award Winners**

2016

"Molecular diagnosis of multi Schistosome parasites from filtered urine from school children in Zambia."

Dr. Nilanjan Lodh

Assistant Professor, Clinical Laboratory Science

2015

"International Research to Improve Planning, Care and Functional Outcomes in Children With Orthopaedic Disabilities: Manila Philippines."

Dr. Gerald Harris

Professor, Biomedical Engineering

2014

"Engineering Synthetic Feedback to Promote Recovery of Self-feeding Skills in Stroke Survivors." (in partnership with the University of Genoa)

Dr. Robert Scheidt, professor, Biomedical Engineering

Alexis Krueger, graduate assistant, Biomedical engineering

"The Nahuatl in Central American Mapping project."

Dr. Laura Matthew, associate professor, History Department

Benjamin Nestor, graduate assistant, History Department

2013

"Designing Human-Computer Interfaces for Elderly People in Taiwan"

Dr. Sheikh Iqbal Ahamed

Professor, Mathematics, Statistics and Computer Science

"Untold Stories: An African Society and the Second World War (Nigeria)"

Dr. Chima J. Korieh

Associate Professor, History Department

Judges:

Dr. Joyce Wolburg, Associate Dean and Professor, Diederich College of Communication

Dr. Lars Olson, Interim Bio-Medical Chair, Biomedical Engineering

2012

"The Mechanism of 'Chinese Traditional Teeth Tapping' in Maintaining Alveolar Bone"

Dr. Dawei Liu, DDS

Associate Professor, Dental Developmental Sciences/Orthodontics

"mHealthMTT: Bridging the Gap in Communication Using a Mobile Based Intervention for Maternal and Child Healthcare in Rural Bangladesh"

Dr. Iqbal Ahamed

Associate Professor, Mathematics, Statistics and Computer Science

Judges:

Dr. Anne Pasero, Chair and Professor of Spanish, Foreign Languages & Literatures

Dr. James Marten, Chair/Professor, History

Ms. Michelle Schuh, Assistant Dean, College of Health Sciences

2011

“Circulations: Death and Opportunity in Southern Pacific Mesoamerica, 1450-1620”

Dr. Laura Matthew

Assistant Professor, History

“Findings from the deployment of e-ESAS: a remote symptom monitoring system for rural breast cancer patients in Bangladesh”

Dr. Iqbal Ahamed

Associate Professor, Mathematics, Statistics and Computer Science

Judges:

Dr. Ellen Eckman, Associate Professor/Chair, Educational Policy and Leadership

Dr. John Pustejovsky, Associate Professor of German/Chair, Foreign Languages & Literatures

Dr. Ruth Ann Belknap, Associate Professor, College of Nursing

2010

Dr. Stephani Richards-Wilson

Assistant Dean for Recruitment and Retention, Klingler College of Arts and Sciences

Dr. M. Therese Lysaught

Associate Professor/Director of Graduate Studies, Theology

Dr. Lars Olson

Associate Professor, Biomedical Engineering

Dr. Sharon Chubbuck

Associate Professor, Educational Policy and Leadership

2009

“The “Itinerant Museum”: Agrarian Reform, Peasant Revolt, and the Cultural Policy of Spain's Second Republic”

Dr. Eugenia Afinoguenova

Associate Professor of Spanish, Foreign Languages and Literatures

“Vamos Juntas: A pilot participatory action research project to assist Spanish speaking immigrant women in moderating life stressors”

Dr. Ruth Ann Belknap

Associate Professor, College of Nursing

“Muslim Outreach for Interfaith Dialogue: Al-Risala Movement’s Mission for the 21st Century”

Dr. Irfan Omar

Associate Professor, Theology

“Emergency dental care training for refugee health providers: An answer to dental care access in long-term refugee camps”

Dr. Toni Roucka

Assistant Professor and Predoctoral Program Director of General Dentistry, General Dental Sciences

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Colloquies

Project Title: Outcomes of Multiple-Visit Root Canal Therapy with Varying Timeframes Between Visits

Faculty Name: Pradeep Bhagavatula, Assistant Professor, Department of Clinical Services

Student Name: Igor Sulim

Introduction: The purpose of this study is to develop a suggested guideline for dental providers completing root canals in multiple appointments. According to American Dental Association, root canal therapy is defined as a treatment of disease and injuries of the pulp and associated periradicular conditions. When a patient presents with a pulp that is necrotic and/or has an associated periradicular disease, the current convention is to treat the tooth in multiple visits. Frequently, general dentists initiate endodontic therapy to alleviate painful symptoms, and then refer the case to a specialist to complete root canal therapy. Temporary restorative materials are placed over the access of the root canal at the end of the initial visit to prevent further spread of bacteria into the root canal space. However, these restorative materials have limited protective properties for long term use. Therefore, it is important to determine if there are adverse outcomes to delaying the completion of a multiple-visit root canal.

To examine this study an electronic claims and enrollment database from Delta Dental of Wisconsin will be used to obtain data between January 1, 2000 and December 31, 2013. Dental insurance claims will be searched for Current Dental Terminology procedure codes D3221 (pulpectomy) D3310 (anterior NSRCT), D3320 (premolar NSRCT), and D3330 (molar NSRCT). The study will focus on cases in which a general dentist performs the initial step of root canal therapy, a pulpectomy, and then proceeds to refer to an endodontist for the completion of a non-surgical root canal (NSRCT). Intervals of 0-2 weeks, 2-4 weeks, 8 weeks, 12 weeks, 16 weeks, and 20 weeks between appointments will be examined. Cases will be followed and considered successful until enrollment is broken or until Current Dental Terminology codes representing extraction, retreatment, or apical surgery are encountered. Cases will have a 1-, 5-, and 10 year follow up for comparison of survival over time.

Significance: Utilizing evidence based dentistry is essential in ensuring that a standard of care is followed by dental providers. Despite the plethora of available endodontic literature, a gap in knowledge still remains. Currently, there are no guidelines on an acceptable timeframe between visits in a multiple-visit root canal. This study will have the advantage of utilizing a large study population with long term follow-up periods. This allows the study to generate significant power of analysis that will be applicable to the uncontrolled environment of dentistry. By examining the outcomes of this study, a suggested guideline can be created to improve treatment recommendations by dental providers when they encounter this frequent situation.

Innovation/Forward Thinking: Endodontic intervention is a global treatment modality for managing pulpal and periradicular disease. Therefore, this study has the potential implication for utilizing evidence based dentistry to enhance the current standard of care by providing innovative suggested guidelines that could substantially improve the outcome of multiple-visit root canal therapy.

Student Involvement: Igor Sulim is a fourth-year dental student serving as a student researcher under the guidance of Dr. Bhagavatula and Dr. Stover. He will be continuing his dental education through the Endodontic Residency program at Marquette starting in the summer of 2018.

References: 1. Burry JC, Stover S, Eichmiller F, Bhagavatula P. Outcomes of Primary Endodontic Therapy Provided by Endodontic Specialists Compared with Other Providers. *J Endod.* 2016 May;42(5):702-5
2. Friedman S. Prognosis of initial endodontic therapy: *Endodontic Topics* 2002;2:59-88.
3. Lazarski MP, Walker WA III, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. *J Endod.* 2001 Dec;27(12):791-6.
4. Mohammadi Z, Shalavi S. Clinical applications of glass ionomers in endodontics: a review. *Int Dent J.* 2012 Oct;62(5):244-50.
5. Siren E, Haapasalo M, Ranta K, Salmi P, Kerosuo E. Microbiological findings and clinical treatment procedures in endodontic cases selected for microbiological investigation. *Int Endod J* 1997; 30: 91-95.

Keywords: root canal therapy, multiple-visit, outcomes

Project Title: Stress and Resilience in Black Women's Lives: Mind, Body, and Soul

Faculty Name: Ed De St. Aubin, Associate Professor, Psychology

Student Name: Alexandria Thompson-Colburn

Introduction: This social justice-oriented, multimethod design is aimed at gaining an understanding of the sources of oppression and strength impacting Black women. Our interdisciplinary team will collect three interrelated data types to capture a biopsychosocial portrait of participants: 1) Survey data (mind) on intersectionality, stress, resiliency, and well-being; 2) Physiological stress data (body) via salivary cortisol at four time-points; and, 3) Narrative data (soul) taken from life story interviews. We have secured commitments from seven community partners, all women who are or have been engaged in activities in the north side. Further, Dr. Staci Young, herself a Milwaukee native and current MCW scholar, has agreed to co-PI. Finally, graduate and undergraduate Marquette students, many of whom are women and/or ethnic minorities, will complete the research team. Project Return, a non-profit engaged in Milwaukee's north side communities for nearly 40 years, has agreed to convert the findings of our research into specific programs designed to improve the lives of black women, their families, and their communities.

Significance: Well over 100 empirical studies demonstrate support for the basic tenets of Minority Stress Theory: Socially-based stress (e.g. discrimination, microaggressions) experienced by members of stigmatized groups can, over time, result in both mental and physical health disparities. Our study builds on this theory, filling current voids in the research literature and channeling the findings to specific programs in the community.

Innovation/Forward Thinking: A limitation of much of the existing literature is it assumes that all black adults are similarly impacted by their social experiences. While all participants will be Black Women, we take an intersectional approach by considering how interconnecting components of identity merge to influence perceptions of self, stress, and mental health. We will sample to achieve diversity in age, socio-economic status, and sexual orientation. Utilization of an intersectional and multimethod approach sets this study apart from past research exploring Black women's experiences, and allows us to accurately capture the full complexity of the lives being studied. We seek to do sound social science that enhances the lives of community partners and participants. We envision our work ultimately serving the needs of Milwaukee Black women, by explicitly asking how we might engage with their communities.

Student Involvement: Alexandria Colburn will be heavily involved in this research project at all stages-including research design, data collection, data analysis, dissemination of results, and ongoing community advocacy. This study is intended to inform her dissertation. The faculty PI has mentored over 175 undergraduate student researchers who have served as co-authors on peer-reviewed conference presentations. We will again form a team of undergraduate researchers to assist at every phase of the study.

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Keywords: Black women, Intersectionality, Community Engagement, Minority Stress

Project Title: Dairy-Manure-Derived Catalyst for Energy and Resource Recovery from Wastewater Biosolids
Faculty Name: Zhongzhe Liu, Research Assistant Professor, Civil, Construction and Environmental Engineering
Student Name: Matthew Hughes

Introduction: The major research goal of this project is to evaluate the catalytic effect of dairy manure biochar on increasing pyrolysis gas (py-gas) yield during wastewater biosolids pyrolysis. Pyrolysis is a process which decomposes carbonaceous materials (e.g. manure, biosolids) upon heating under anaerobic conditions. The resulting products are biochar, py-gas, and bio-oil. Biochar is usually used as a precursor for activated carbon making or as a valuable soil amendment which improves plant growth. Py-gas and bio-oil can both be used as a fuel. However, bio-oil from biosolids pyrolysis normally accounts for at least 40% of the total product mass¹ and requires costly pretreatment due to its corrosive and unstable properties before it can be used as a clean fuel². In contrast, py-gas can be easily burned in gas engines for energy recovery. Therefore, cost-efficient catalyst is of great interest for reducing bio-oil yield and increasing py-gas yield during the biosolids pyrolysis. A new process is proposed by using dairy manure biochar as the catalyst for improving energy and resource recovery from wastewater biosolids (Figure 1).

Significance: The negative impacts of improper disposal of dairy manure on environmental water quality, public health, and air quality are a common problem around the world. As a dairy land, Wisconsin is currently facing this tough problem. For example, one third of the residents of Kewaunee County, Wisconsin, currently do not have reliable drinking water supplies due to the contaminated groundwater majorly caused by local unsafe manure disposal. Manure pyrolysis can destruct and stabilize contaminants in its biochar. On the other hand, in the United States, over 8 million dry tons of wastewater biosolids are produced annually and 60% of biosolids are land applied³, such as the heat dried biosolids produced by municipalities such as the Milwaukee Metropolitan Sewerage District (MMSD). However, some residual pollutants in biosolids such as emerging contaminants of concern (e.g. antimicrobials) could pose threats to the water system during land application. Catalytic biosolids pyrolysis (e.g. using manure biochar as a catalyst) can enhance energy recovery in terms of upgraded py-gas and bio-oil. Also, pyrolysis can convert biosolids to a clean biochar product by destructing residual pollutants.

Innovation/Forward Thinking: The protection of public health and the environment and the production of renewable energy are our responsibilities in a forward-thinking and sustainable community. We need to develop technologies capable of synergistic processing and disposal of various environmental wastes such as dairy manure and wastewater biosolids. An innovative process as proposed in this project can convert wastes to useful products that contain minimized contaminants. This project will be the first research to determine the catalytic effect of manure biochar to improve the energy recovery during biosolids pyrolysis. In particular, this project reflects the Marquette's Jesuit mission, Clean Water, and the themes in Marquette's strategic plan, Sustainability of Valuable Resources and Research in Action.

Student Involvement: Matthew Hughes was involved in a previous work regarding wastewater biosolids pyrolysis that was recently published in a top Environmental Engineering journal, Environmental Science & Technology. He will conduct catalytic pyrolysis experiments with data processing by integrating his Mechanical Engineering background. His personal research goal in this project is to publish his first peer-reviewed paper in a top sustainability journal (e.g. Renewable Energy).



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Keywords: Dairy Manure, Wastewater Biosolids, Biochar, Catalytic Pyrolysis

Project Title: Point-of-care (POC) diagnosis for Schistosomiasis from urine by LAMP

Faculty Name: Nilanjan Lodh, Assistant Professor, Clinical Laboratory Science

Student Name: Miriam Price, Mary Thao

Introduction: Schistosomiasis has been called the deadliest of the neglected Tropical diseases (NTDs) by the US Centers for Disease Control and Prevention (CDC) with more than 200 million people infected and close to 700 million at risk [1]. It is also the second most common parasitic disease, after malaria. The disease is transmitted through fresh water that contains the larvae of worms known as blood flukes or flatworms. In sub Saharan Africa two major human schistosomes, namely *Schistosoma mansoni* and *S. haematobium* often occur in same place, largely affecting children. The proposed diagnostic (Loop-mediated isothermal amplification: LAMP) is the target of a major mass treatment program, which will initially address issues such as sensitivity and specificity of a diagnostic test. The convenience of the process involves filtering 40 - 50ml urine through coarse filter paper; the paper dried, packed in individual plastic sleeves with desiccant, and is easily and inexpensively transported to a lab where DNA can be extracted from the paper, amplified and the product detected by electrophoresis. There is no need to transport heavy materials, specimens and packages. This procedure will be used effectively and efficiently for both *S. mansoni* and *S. haematobium*. These procedures are entirely novel and there is no need to collect and process stool or urine to scrutinize them for parasite eggs.

Significance: For children aged 6 – 15, the infection prevalence and intensity peaks, which impacts the growth delays, delayed cognition, attention deficit disorders, poor performance in school and a negative effect on the overall growth and quality of the child's life. Recognizing the public health impact of Schistosomiasis, the World Health Organization (WHO) is urging member states to regularly treat at least 75% and up to 100%, of all school-aged children at risk of morbidity. For control strategies based on targeted Mass Drug Administration (MDA) to succeed it is essential to have a simple, easy to operate sensitive and accurate test as low-level active infection often occurs after MDA. Current available diagnostic tools, such as egg detection in stool by Kato-Katz (KK), detection of Circulating Cathodic Antigen (CCA) for *S. mansoni* and detection of blood (hematuria) in urine for *S. haematobium* lack sensitivity in low intensity settings. We have detected *S. mansoni* and *S. haematobium* parasite species-specific small repeat DNA fragments from urine sediment captured on filter paper by PCR [2]. The rationale of our approach is that DNA detection in urine would discriminate between two above mentioned parasite species by LAMP as efficiently as PCR in individuals where viable infection is still present post-MDA, as indicated by the presence of parasite DNA in the urine.

Innovation/Forward Thinking: Our future aim includes implementation of a parasite-specific repeat DNA detection both in the field and in clinics as a Point of Care (POC) diagnosis along with a common sample preparation procedure within different endemic settings. The usage of PCR as a diagnostic test has technical limitation. PCR amplification requires the use of a thermocycler for amplification and electrophoresis equipment for visualization. These are difficult to implement in resource constraint areas and under field conditions. The need for the equipment can be replaced in the field using LAMP [3]. LAMP procedure uses three sets of primers to amplify six regions of the target DNA. Amplification of the DNA occurs independently of a thermocycler, and will change turbidity if the reaction is positive [4]. Innovative diagnostic tools for the "end-game" of control interventions are warranted in the control of schistosomiasis and LAMP based method can be the solution.

Student Involvement: Two undergraduate student research workers from the Department of Clinical Laboratory Science (CLS) will be involved in the project from genetic material extraction and amplification by LAMP to data collection, data analysis and scientific presentation of outcome. They are already working on the amplification via PCR of the samples.

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Keywords: Schistosomiasis, Filtered urine, LAMP, Molecular diagnosis

Project Title: Electrochemical Methods for the Removal of Emerging Contaminants in Drinking Water for Small Water Systems

Faculty Name: Brooke Mayer, Assistant Professor, Civil, Construction, and Environmental Engineering
Patrick McNamara, Assistant Professor, Civil, Construction, and Environmental Engineering

Student Name: Donald Ryan

Introduction: The goal of this project is to evaluate electrochemical treatment (electrocoagulation and electrooxidation) for micropollutant removal in drinking water, with a particular emphasis on applications for small, rural water systems. Electrochemical water and wastewater treatment methods have historically been more frequently used to process wastewaters, e.g., oil and gas, but have recently gained traction as a potential drinking water treatment technology, particularly for small decentralized systems. While it is known that electrochemical systems can remove pollutants such as turbidity, their performance with respect to emerging contaminants in drinking water sources (like pharmaceuticals and consumer products) is not well understood. The feasibility of this technology will also be assessed by analyzing the energy requirements with respect to the energy inputs needed to achieve contaminant removal goals.

Significance: Electrochemistry can be an innovative treatment method to induce coagulation and oxidation processes in water by passing electricity through electrodes. Coagulation and oxidation are well-suited processes for many drinking water operations to meet regulatory requirements for safe drinking water. However, coagulation and disinfection/oxidation processes require many chemicals and materials that must be transported from off-site and require extra chemical lines to flow through a treatment plant, which can increase capital and operation/maintenance costs. Small rural water treatment plants can struggle to meet drinking water standards as these traditional processes may be too expensive or operationally intensive for small operations. Electrocoagulation together with electrooxidation can be an attractive option for small water systems because the chemicals needed for water treatment can be generated on site, rather than needing to be transported to the facility and dosed directly. The in-situ production of these chemicals can decrease transportation costs for chemical delivery, thereby improving accessibility to clean drinking water for small rural communities.

Innovation/Forward Thinking: Small water systems that serve less than 10,000 people comprise 97% of public water systems in the U.S. For such systems, it is important to be cognizant of water treatment technologies that do not require large operations and maintenance costs and long construction periods to implement. Electrochemical technologies can even be scaled down to mobile systems that could provide aid to areas following disasters that may deteriorate water supplies and water infrastructure. A barrier to the implementation of electrochemical water treatment is the lack of understanding of operating parameters in a drinking water treatment setting. This research will focus on treatment efficiency with respect to the contaminants that are not generally removed well by conventional drinking water treatment: pharmaceuticals and personal care products. If electrochemical systems can be optimized with respect to treating pharmaceuticals and personal care products, which are some of the most recalcitrant waterborne contaminants, they can be effective for low-maintenance small-scale systems wherein a broad range of contaminants can be removed from drinking water using only electrochemical treatment. This research will provide information about the removal efficiency of these technologies as well as the energy inputs necessary for contaminant removal.

Keywords: Environmental Engineering, Drinking Water Treatment, Emerging Contaminants, Electrocoagulation and Electrooxidation

Project Title: Removal of Estrogenic Pollutants from Drinking Water: The Impact of Electrocoagulation
Faculty Name: Patrick McNamara, Assistant Professor, Civil, Construction, and Environmental Engineering
Student Name: Cassidy O'Malley

Introduction: The focus of this research is on the presence of estrogenic contaminants in the environment and the emerging concerns they pose to public health. The goal of this research is to generate knowledge regarding the removal mechanisms of estrogens from drinking water sources via the treatment technique electrocoagulation.

Significance: Four estrogens are analyzed in this study. Three of which are naturally occurring, one synthetic, and all are found on the EPA's Contaminant Candidate List (CCL). The CCL lists chemicals and microbial contaminants that are known or anticipated to occur in public water systems. Research, therefore, into the occurrence, human and environmental health impacts, and treatment potential of estrogens in water systems is necessary. It is known that conventional drinking water treatment processes, coagulation and sedimentation, have minimal impact on the removal of estrogen. Incomplete removal leads to the compounds entering the environment where they are able to accumulate and persist. Known health effects involve direct impacts to the development and functioning of wildlife and human reproductive systems.

Innovation/Forward Thinking: This research investigates the development and optimization of the treatment technology, electrocoagulation (EC), for the removal of estrogenic compound from drinking water. EC uses metals electrodes connected to a power source to generate in-situ coagulants. Through the oxidation process occurring, around 90% of the contaminants can be removed. Forward thinking for this project involves further optimization of the system for potential industry relevant, economic benefits.

Project Title: Fine-Scale Plant Response To Environmental Change Using A Novel Sensor System

Faculty Name: Stefan Schnitzer, Director of Environmental Studies, Biological Sciences

Student Name: David DeFilippis

Introduction: Determining the mechanisms responsible for the abundance and distribution of organisms is a central goal in ecology. Mean annual rainfall and the severity of seasonal drought is major determinate of tropical plant species abundance and distribution. Tolerance to drought is essential to explain the presence of species in seasonally dry forests. However, explaining the relative abundance of these species may be attributed to their performance during drought rather than merely their tolerance to drought. Determining the plant species that have a dry season growth advantage is critical to understand how an increasingly dynamic climate will change a species' abundance and distribution over time.

Significance: The ability to distinguish between the dry season growth advantage and dry season tolerance hypotheses has proven exceedingly difficult due to the difficulty in measuring fine-scale plant response to the environment for replicated species. We propose to test the dry season growth and tolerance hypotheses using an affordable and novel wireless sensor system that we have developed to measure fine-scale changes in plant growth. Specifically, we will measure the diurnal stem diameter response of trees and lianas in three forests across a rainfall gradient to determine whether the species that grow during seasonal droughts are the most abundant. Distinguishing the dry season growth hypothesis from the tolerance hypothesis we will explain the presence and persistence, as well as the relative abundance of species across rainfall gradients. This study has the capacity to fundamentally change how we think about seasonal drought as a predictor of species relative abundance.

Innovation/Forward Thinking: The newly developed electronic sensor system can collect high-resolution, high-resolution measurements throughout the day for hundreds of individuals per site at a relatively low price per sensor (~\$15). At the center of the dendrometer system is a sensor made of metal-infused elastic that is extremely sensitive to plant diameter growth. The sensor is paired with an inexpensive yet robust microprocessor that sends the data via a wireless network to a custom data logger and cellular gateway, which both stores the data continuously and also transmits data hourly to our storage server via local cellular networks. The data can be easily retrieved from our server via a web-based application. Due to the relatively low cost and ease of producing the sensor system, I can test the dry season growth and tolerance hypotheses on a much larger number of tree and liana species than was previously possible. Furthermore, because all sensors record growth at the same time throughout the day, it is easy to compare diurnal diameter changes for all individuals and species, leading to insights into how tree and liana species respond to daily and seasonal water stress. I predict that the tree and liana species that are most abundant will be the ones that can maintain diameter growth throughout the dry season, and that this growth effect will diminish with decreasing mean annual precipitation.

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Project Title: Renewable Energy from Wastewater: Biotech to Convert Pyrolysis Liquid to Methane Fuel

Faculty Name: Daniel Zitomer, Professor, Civil, Construction, and Environmental Engineering

Student Name: Seyedehfatemeh Seyedi

Introduction: Pyrolysis is a thermochemical process yielding py-gas for energy and biochar, a valuable carbon soil amendment, from wastewater solids. Aqueous pyrolysis liquid, known as APL, is also produced and, unfortunately, has no apparent use. However, the organics in APL possibly could be converted to biomethane via anaerobic digestion to increase renewable energy production. However, APL contains various organics such as phenols that can inhibit microbes in anaerobic digesters (Tsai et al., 2009, Mumme et al., 2014). APL also contains a high concentration of NH₃-N. Air stripping is one method to reduce NH₃-N concentration (Chen et al., 2008).

Significance: Aqueous pyrolysis liquid (APL) is a byproduct for thermochemical renewable fuel production and presently has no apparent use. If APL is discharged without processing or treatment, then it can pollute the environment because of its high organic strength. However, if the organics in APL could be converted to biomethane via anaerobic digestion, then additional renewable energy could be produced from APL. Although APL contains various organics such as phenols that can inhibit microbes that produce methane (Tsai et al., 2009, Mumme et al., 2014). We are working to develop an anaerobic digestion process to convert APL to methane fuel. Our research regarding anaerobic digestion of APL from wastewater thermochemical treatment will be described.

Innovation/Forward Thinking: The organics in APL may be converted to biomethane via anaerobic digestion under proper conditions to increase renewable energy production from wastewater.

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Keywords: Renewable energy, Anaerobic digestion, Thermochemical process, Pyrolysis liquid

International Posters

Project Title: An Elderly Safety Package System: Monitoring and Protecting Older People from Fall Injuries Using a Wearable Airbag and Sensors

Faculty Name: Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science
Chandana Tamma, Adjunct Assistant Professor, Electrical and Computer Engineering

Student Name: Mohammed Balfas

Introduction: Every year millions of Muslims come to the Holy City of Makah in the Kingdom of Saudi Arabia for performance Hajj and Omra (Limited to actual Haj, 2017). Depending on the ability, every Muslim must perform Hajj at least once in their life (Mufti, 2006). For many reasons, according to Al-Ittihad Newspaper, around 60% of the number of pilgrims are old pilgrims which that means they might need special care during their trips (Al-Ittihad Newspaper, 2017). Numerous elderly pilgrims have existing diseases such as diabetes, hypertension, arthritis, epilepsy, liver, kidney disease, heat exhaustion and heatstroke, which can be worsened during Hajj environments (Shuja, 2016). In this project we would like to address and eliminate these obstacles and make a safe pilgrimage for elderly. We're going to build a system which can track their steps in the map using motions sensors with algorithms for human activity recognition integrated with GPS and Wi-Fi. Also, the system can detect and protect elderly pilgrims from fall injuries using a wearable airbag and send GSM SMS SOS (Save Our Souls) in order to avoid getting worse problems and give them the aids based localization.

Significance: I'm choosing to study this because I am seeing that in old age, many people have faced the experience of weakness, fear, loneliness and depression. Therefore, they don't have good moments of their lives because of this (Dionyssiotis, 2012) (Singh, 2009). In this project, we might help them to recover the confidence and dependability in themselves. Further, this project would also help the elderly protect and reduce fall injuries, so they can enjoy with their life. For example, we're focusing on elderly people traveling to Makkah in order to perform some religious duties. The importance of the project clearly seems if we know the medical care of a hip fracture is very expensive (Drury, 2016). Therefore, we try to build a system which track and mentor the movements of the elderly during the trip in order to ensure their safety.

Innovation/Forward Thinking: The project is going to be a next step and integrated with other research, and it will use and solve a big issue for the elderly by combining solutions. In the general, the project will face challenges in applying the approaches to the elderly. The elderly might not choose to use or test the system because they are afraid to use it for the first time, and they don't want to show any weakness to others. Also, the system must be comfortable when wearing it. Moreover, the system will need to work with some equipment and connect to the server which means the cost will be high, but we know the system will save life and more money for the elderly. The project is in international category, and the grant money will be used to for buying equipment.

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Keywords: Wearable Airbag, Fall Detection, Localization, SOS

Project Title: Automated Detection of Diabetic Retinopathy and Building Cost-effective Fundus Camera

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science

Richard Love, Medical Oncologist, Amader Gram, Bangladesh

Tanzima Hashem, Associate Professor, Computer Science and Engineering, Bangladesh University of Engineering and Technology

Amy Van Hecke, Professor, Psychology

Md Munirul Haque, Research Science, Center for Healthcare Engineering

Student Name: Jannatul Ferdouse Tumpa, Riddhiman Adib, Nazmus Sakib

Introduction: Diabetic retinopathy, a Retinal disease, is one of the leading causes of blindness worldwide. The blindness can be avoided or cured if diabetic retinopathy can be diagnosed at an earlier stage. To detect the retinal diseases, eye specialists need to take Fundus images of the back of the eye and then look for few specific properties like, the initial sign of microaneurysm, hemorrhage, yellow spots, cotton wool, abnormal growth of blood vessels, etc. to identify abnormal eye conditions. A significant cost of screening by this method comprises the salaries of staff trained to review retinal photographs. Besides, the device used for taking the fundus images is very costly, bulky and immobile in the current situation.

Our goal is to reduce the cost of screening for diabetic retinopathy in twofold approaches. The first approach is to build a Fundus Camera Using Android Mobile Phone in the Ubiquitous environment that will take images inside the fundus of the eye preserving the image quality but will be compact and cost-effective. The second approach is an Automated detection of diabetic retinopathy without requiring any human grading which will significantly reduce the cost associated with screening.

Significance: Since patients with diabetes are at higher risk of developing retinal diseases, early detection through regular surveillance by clinical examination or grading of retinal photographs is essential in order to prevent vision loss. Annual screening of the retina is recommended but it presents a huge challenge, given that the number of people with diabetic retinopathy (DR) is expected to increase threefold in the United States by 2050 (Centers for Disease Control and Prevention, 2011) and to double in the developing world by 2030, particularly in Asia, the Middle East, and Latin America (Tufail, et.al.,2017). Thus, our approach for automated screening of diabetic retinopathy will greatly reduce the workload of human graders as well as the reduced cost will help the diabetic patients to afford regular screening.

Innovation/Forward Thinking: Usher et.al developed Software systems and applied automated techniques to detect diabetic retinopathy in images from a diabetic screening population(Usher et. al., 2003). Niemeijer et. al. also developed similar machine learning-based automated system. However, existing works could identify the images with no retinopathy with great accuracy but could not analyze the images which were judged as ungradable by the clinician. Moreover, we have already collected images of two thousand patients having diabetes with a purpose to machine-learn our system, and we propose to find a biomarker of diabetic retinopathy from fundus images for identifying the disease with higher accuracy without any human grader. Besides, intending to reduce the cost of screening further, we will build a Fundus Camera Using Android Mobile Phone which will make this screening more available and affordable.

Student Involvement: Jannatul Ferdouse Tumpa: System development and Mathematical model development for automated detection of diabetic retinopathy, Riddhiman Adib: Pre-processing and analysis of Fundus retinal images, Two other students from Bangladesh University of Engineering and Technology are working on building the Android based Fundus camera under supervision of Dr. Tanzima Hashem, Associate Professor, Bangladesh University of Engineering and Technology.

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Keywords: Diabetic retinopathy, Automated detection, Fundus camera, Image Analysis

Project Title: Psychometrics Properties of the Arabic Version of the Positive Thinking Skills Scale (A-PTSS) among First Generation Middle East Immigrants

Faculty Name: Abir Bekhet, Associate Professor, Nursing
Magdala Maximous, Professor from Alexandria University, Egypt, Nursing
Isis Gohar, Lecturer from Alexandria University, Egypt, Nursing

Student Name: Veronica Nakhla, Rawan Oudeh, Nadia Malik

Introduction: Middle Easterners (ME) are one of the fastest growing immigrant groups in America. The number of immigrants from the Middle East has grown more than seven-fold, reaching 1.5 million in 2000 as compared to less than 200,000 in 1970. Migrant studies in the US have rarely covered the ME population and have never distinguished between first and second generations. First generation migrants are at an increased risk of mental illness, especially depression. In 2016, it was suggested that quality research among ME is urgently needed, specifically, the use of culturally specific validated measurement tools for assessing migrant mental health. Depression is currently considered the second leading cause of disability worldwide. Positive thinking is a cognitive process that helps individuals to deal with problems and has been suggested as a useful strategy for coping with adversity, including depression.

Significance: The Positive Thinking Skills Scale (PTSS) is a reliable and valid measure that captures the frequency of use of positive thinking skills that can help in the early identification of the possibility of developing depressive thoughts. A cut off score of 13 was determined to be a point at which referral, intervention, or treatment would be recommended. Consequently, this can help in the early identification of depressive thoughts that precedes the development of clinical depression. The PTSS has been translated into Turkish and Chinese and its psychometrics have been tested in those populations. However, there is an urgent need to translate the PTSS into the Arabic language and to measure its psychometric properties.

Innovation/Forward Thinking: To date, there is no measure of positive thinking skills in the Arabic language. This study is innovative in translating and testing the psychometric properties of the Arabic version of the PTSS as an initial step toward implementing a positive thinking training intervention among first generation ME immigrants.

Student Involvement: Veronica, Rawan, and Nadia have access to first generation Middle Eastern immigrants through their affiliations with Middle Eastern churches and Mosques. They will help in recruiting the participants (n=100), collecting and analyzing the data, and preparing the manuscript.

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Project Title: Auditory Feedback Training of English-Accented Spanish Pronunciation

Faculty Name: Jeff Berry, Associate Professor, Speech Pathology & Audiology

Sonia Barnes, Assistant Professor, Languages, Literatures, and Cultures

Steven Long, Associate Professor, Speech Pathology & Audiology

Student Name: Itzel Matamoros, Kathryn Higgins,

Introduction: The objective of this project is to complete the second part of a research study on accented speech in English speakers who learn Spanish as a second language (L2). In part one of this work, acoustic analysis was completed for nine native (L1) speakers and fourteen L2 learners of Spanish to characterize speech sound differences. Vowel acoustics distinguished L1 and L2 talkers, as might be expected due to perceived differences in accent. These results also provided critical data for part two of this project: auditory feedback-driven adaptive learning. In the planned experiments, L2 learners will hear acoustically manipulated speech through headphones in real-time while saying words with targeted speech sounds. Acoustic manipulations will be based on previously analyzed L1-L2 acoustic differences, and will be used to trigger involuntarily adaptations to movements of the tongue, lips, and jaw. This learning technique aims to improve pronunciation and auditory discrimination, effectively reducing accent.

Significance: The U.S. Census Bureau reported that in 2011 at least 37.5 million Americans speak Spanish at home [1]. Given these findings and the fast-growing number of Americans who are learning to speak Spanish, a native-like Spanish accent is essential for social and professional interactions with L1 speakers [2], helping L2 learners avoid negative perceptions. We plan to use auditory feedback training that has previously only been used in studying sensorimotor control [3] to reduce accent in L2 Spanish, with the goal of improving the quality of the relationships established in bilingual work and social settings.

Innovation/Forward Thinking: The auditory-biofeedback training approach used in the current study will substantially advance accent modification techniques, using methods developed for studying sensorimotor integration. Auditory feedback manipulations can facilitate real time, involuntary changes in neural control systems during speech [4]. After analyzing the acoustics of L1 and L2 Spanish we now have the capacity to manipulate auditory feedback more effectively for pronunciation modification.

Student Involvement: Itzel Matamoros and Kathryn Higgins will both continue to refine and extend the analysis of acoustic data from part 1 of this project, with the assistance of undergraduates Andrea Garcia and Rachel Garcia. The students will also recruit and screen potential participants, obtaining necessary data to set up auditory feedback training. Ms. Matamoros and Ms. Higgins will run these training experiments and analyze the resulting data. All work will be completed under the guidance of Dr. Berry, Dr. Long and Dr. Barnes.

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Keywords: Spanish, Accented Speech, Pronunciation Training, Auditory Feedback

Project Title: Multiscale Analysis of Soil-Strap Interactions in Mechanically Stabilized Earth Retaining Walls

Faculty Name: Jonathan Fleischmann, Assistant Professor, Mechanical Engineering

Student Name: Maxwell Willingham

Introduction: Mechanically stabilized earth (MSE) retaining walls are commonly used everywhere to stabilize slopes under a variety of loading situations. Horizontal layers of galvanized steel straps or geosynthetic grids are used to provide added friction and stability to the slopes. Current design of these walls is done through a physical experiment known as a pullout test. Much of this design process involves a high level of uncertainty. However, using numerical simulations the pullout test can be replicated in a virtual testing environment which is where the focus of this research lies. This allows us access microscale data that is otherwise unobtainable through physical testing.

Significance: Utilizing the numerical model, we can validate physical test results and analyze the microscale interactions between the discrete soil particles and the reinforcement strap. In addition, force chains between the particles can be observed to reveal important details that will reduce uncertainties in the design of MSE walls. The conclusions derived from the simulations will help develop a better design process for MSE walls in future applications.

Innovation/Forward Thinking: The virtual testing environment is constantly under development with new results being examined every day that bring us one step closer to replicating actual physical test results. Within the next six months the scope is to have comparable numerical results to the experimental data and examine in refined detail the microscale interactions in these reinforced walls. These results and findings can then be extrapolated to draw valuable conclusions for the MSE wall design process.

Student Involvement: Currently, one graduate student is working on the development of the numerical simulation and validation under a Legacy Initiative Research Grant with physical testing being done by a PhD student in Marquette's Civil Engineering Department. There are future plans to apply for additional grants to continue our multiscale development in this field.

References: 1. Chareyre, B., & Thoeni K., & Giacomini A. (2016) "Modelling of Deformable Structures in the General Framework of the Discrete Element Method." *Geotextiles and Geomembranes* 44.2
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3. "MSE Precast Panel Retaining Walls." Reinforced Earth® | The Reinforced Earth Company.

Keywords: Numerical, Multiscale, Granular, Mechanical

Project Title: Scar-free Wound Healing in a Jamaican Gecko
Faculty Name: Tony Gamble, Assistant Professor, Biological Sciences
Student Name: Shannon Keating, Aaron Griffing

Introduction: Imagine being able to heal spinal cord injuries or regrow damaged skin without leaving a scar. While this may sound like science fiction but there are other animal species that can easily repair these kinds of wounds. Finding inspiration in nature may be one way of solving some medical problems. Tissue regeneration and wound healing in particular can benefit from emulating the innovative solutions found in nature. While many animal species are useful in this effort, geckos, a kind of lizard, may hold the key to solving these problems, as they are able to regenerate nervous tissue and exhibit scar-free wound healing (Delorme, Lungu, & Vickaryous, 2012; Jacyniak, McDonald, & Vickaryous, 2017). Regional integumentary loss (RIL) involves losing large patches skin in response to attempted predation. It is similar to tail loss as a means to escape predators with minimal damage. RIL has evolved several times independently among geckos (Bauer & Russell, 1992) and while the loss of skin is dramatic, most individuals heal with no scarring or long-term damage. We propose to sequence and compare genes that are expressed in the skin of several gecko species with and without RIL. The aim is to characterize the genetic pathways unique to skin shedding species with an eye towards understanding how these genetic mechanisms may be operating in humans and other mammals that lack regenerative capabilities. We have already obtained samples from one RIL gecko species and three non-RIL gecko species and propose to obtain at least one more RIL species, the Jamaican Giant Gecko (*Aristelliger praesignis*).

Significance: We will use this data to apply for an NIH R01 grant that would examine this preliminary list of important genes and attempt to characterize the cellular and tissue-wide healing response with an eye to translating our findings to a mouse model (with collaborators).

Innovation/Forward Thinking: These results will be the first genetic characterization of RIL in any lizard species and will represent a significant advance in the genetic pathways involving scar-free wound healing. Field work will take place in Spring 2018 with RNA sequencing following soon after. We hope to have preliminary data available for an NIH R01 submission in 2019.

Student Involvement: PhD students Shannon Keating and Aaron Griffing will lead the Jamaica expedition in Spring 2018. Both students have done previous field work in Jamaica and are familiar with permitting and travel conditions.

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Keywords: Regeneration, Evolution, Genetics, Lizard

Project Title: Guided Implant Surgery: Influence of Operator Experience

Faculty Name: Arndt Guentsch, Chair of the Department of Surgical Services and Associate Professor of Periodontics, School of Dentistry - Oral Surgery and Periodontics

Student Name: Seth Butcher

Introduction: Over the past few decades, dental implants have emerged as new option for the replacement of missing teeth and as the foundation for implant-supported prostheses. Advancements in imaging and the advent of surgical guides have made implant placement a more predictable, and therefore successful, procedure (Vercruyssen et al., 2014; Orentlicher & Abboud, 2011). Generation of static surgical guides depends on accurate cone-beam computed tomography (CBCT) imaging, specialized implant optimization software, and precise fabrication techniques, (Greenburg et al., 2015; Moraschini et al., 2015). These guides allow partial or complete guided implant surgery (Mandalaris et al., 2010). The aims of this study are to determine the accuracy and reliability of implant placement using static surgical guides and to evaluate the effect of operator experience on these parameters. A series of identical mandible analogs, gained from CBCT of a patient with partially edentulous dentition, will be fabricated via stereolithography. An implant treatment planning software will be employed to generate surgical guides for the ideal placement of implants within these mandibles. A trained clinician in implant placement will place n=40 implants into n=10 of mandibular replicas. Next, an inexperienced implant clinician, a predoctoral dental student, will perform the same procedures. The precision and reliability of the implant placements as well as the influence of operator experience will be analyzed.

Significance: Several studies have shown the potential accuracy of implant placement using static surgical guides, but none have investigated the precision and reliability within the same study. This study may identify pitfalls of operator inexperience and help implant placement curriculums better train future practitioners. The findings of this study may suggest that the use of static surgical guides allows even inexperienced operators/surgeons to place implants in a predictable manner, which would allow underserved populations worldwide access to specialized dentistry.

Innovation/Forward Thinking: To the best of the investigators' knowledge, no other study has employed serial 3D-printed mandibles in order to determine predictability in implant placement using static surgical guides, nor to determine effect of clinician experience. Implant placement precision, furthermore, would be impossible to determine without our novel approach or similar protocol and the effect of clinician experience cannot be ethically studied in live human subjects.

Student Involvement: Seth Butcher and Brinda Shah, predoctoral students at the Marquette University School of Dentistry, developed the study design and will fulfill the role of "inexperienced clinician."

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Keywords: Dental Implants, Guided Surgery, Cone Beam Computed Tomography, Clinical Experience

Project Title: Faceless: Anonymity, Sarahah and Development

Faculty Name: Shion Guha, Assistant Professor, Mathematics, Statistics and Computer Science

Student Name: Fayika Farhat Nova

Introduction: The concept of anonymity has become very popular among the internet users in recent times. Everyday thousands of people are getting attracted to the idea of anonymity in virtual world and trying out new online applications that allow them to be so. Anonymity is a power, which lets the online users be faceless and perform activities online without any trace and identification. There are substantial differences between how people between developed and developing countries perceive this notion of anonymity because of the differences they have in their surroundings. Sarahah is one of the newly emerging anonymous applications that has become extremely viral within a few days of its released and people around the world are using it for distinctive purposes. We want to focus on this application and address some of the research interests we relate to anonymity.

Significance: As Sarahah is a relatively new anonymous application, interesting behavioral aspects have been noticed in the Sarahah users online that can answer research questions like reasons behind preferring anonymity, interesting personality traits and judgements, based on their cultural background and status.

Innovation/Forward Thinking: We want to address the perception difference between a developed country user and developing country user when they experience anonymity

-We will focus on the multicultural aspect of anonymity

-We want to see how audience difference between this multicultural background can influence the authority over anonymity

-We want to see how privacy concerns are perceived and managed in an international aspect

Student Involvement: -Literature Review

-Research proposal design

-Field Research management

-Survey and interview conduct

-Translation and transcription

-Analysis of the data

-Grant design

References: 1. Hirsch, A. O., Birnholtz, J., & Hancock, J. T. (2017). Your post is embarrassing me: Face threats, identity, and the audience on Facebook. In *Computers in Human Behavior* (Vol. 73, pp. 92-99).

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Keywords: Anonymity, Sarahah, Multiculture, Identity

Project Title: Changes in Handling Properties and Biocompatibility of Root Canal Sealers during Warm Vertical Compaction

Faculty Name: Mohamed Ibrahim, Clinical Assistant Professor, School of Dentistry - Endodontics

Student Name: Seth Butcher

Introduction: The aim of this study is to analyze changes in set time, flow, porosity, and biocompatibility of several endodontic sealer materials during the warm vertical obturation method. The success of endodontic therapy is dependent on the development of a hermetic seal on both sides of the root canal system (Ng et al., 2008). Endodontic sealer materials are an essential adjunct to traditional gutta percha points, which has led to increased interest in identifying a superior variant (Al-Haddid & Aziz, 2016). Warm vertical compaction is an obturation method commonly employed to facilitate a dense and regular fill similar to traditional cold lateral methods (Peng et al., 2007). In using this method, the sealing materials are heated up to 200°C, which has been shown in vitro to alter their set time, flow, and porosity (Qu et al., 2016). A recent letter to the editor, however, has highlighted an important flaw in the clinical relevance of previous testing methods, which we aim to overcome via our novel in vitro protocol (Al-Haddid, 2017). Our study design is compliant with ISO 6876, and we plan to pass endodontic sealer material through an adequately prepared root canal system via an equivalent warm vertical compaction method, thereby generating material samples closer to those found in clinical scenarios.

Significance: Endodontic sealers and obturation methods are essential components in root canal therapy, and their clinical effectiveness requires further research to ensure more ideal treatment outcomes. Set time, flow, porosity, and biocompatibility are important considerations when selecting a sealer material, and changes in such properties during different obturation methods should be well understood. This research attempts to address a significant problem in the literature, with immediate clinical relevance. Endodontic therapy is not a uniquely American procedure. Therefore, the implications of this study affect all regions of the world where root canal treatments are performed.

Innovation/Forward Thinking: To the best of our knowledge, no research of endodontic sealer materials has used prepared extracted teeth for closer approximation of the clinical scenario. A problem in the literature has been previously identified regarding clinical equivalence of in vitro models, which our protocol overcomes.

Student Involvement: Seth Butcher is a predoctoral student at the Marquette University School of Dentistry. He has been tasked with developing the protocol, performing or helping to perform the trials, analyzing the results, and writing the subsequent publication.

References: 1. Ng, Y., Mann, V., Rahbaran, S., Lewsey, J., & Gulabivala, K. (2007). Outcome of primary root canal treatment: systematic review of the literature – Part 2. Influence of clinical factors. *International Endodontic Journal*, 41(1), 6-31. doi:10.1111/j.1365-2

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Keywords: Endodontics, Root Canal Sealers, Material Sciences, Warm Vertical Compaction

Project Title: Family Caregivers' Experiences of Caring for Children with Special Health Care Needs in Ireland

Faculty Name: Norah Johnson, Associate Professor, Nursing

Student Name: Bridget Fredericks

Introduction: Approximately 2.8 percent of children under age 18 years (about 9.4 million) in the United States, have special health care needs (CSHCN) [i.e. long-term health problems (e.g. traumatic brain injury, long term ventilation, developmental disabilities)] [1]. Caregiving for CSHCN, is emotionally draining, costly, time consuming, and it may be provided by extended family members i.e. grandparents and siblings [2]. In a survey of families of CSHCN (n=40,723), 56.8% of the families of more-complex CSHCN experienced financial problems, with 54.1% unable to work because of the child's health, 48.8% had unmet medical service needs, and 33.1% had trouble accessing non-medical services [1]. By contrast, in Ireland where approximately 3.5 percent of children have a disability [3], it is not known if families experience the same social and financial problems as families in the U.S., where social and medical services are fee-based, necessitating broader engagement for U.S. family members in the child's care. Thus, the purpose of this study is to better understand experiences of families of CSHCNs in Ireland. A second objective is to understand the cultural/policy contributing factors to the family-provider relationships of family members.

Significance: With family members supplementing the parents' care of CSHCN in the U.S., insight on the current state of grandparent and sibling experience in Ireland would be helpful in order to inform possible interventions that could impact family and child health here in the U.S. Findings of this important study will inform other studies and health care policy in the U.S., where many families cite unmet medical service needs, and in Ireland, where medical services can be obtained with the National Health System.

Innovation/Forward Thinking: We plan to collaborate with Dr. Maria Brenner on a qualitative research study in Dublin Ireland. In the project, we will build on and expand our past individual research. Working together, we propose to fill a gap in the literature by gaining a better understanding of the family (grandparents and siblings) experience of caring for CSHCN in Ireland. The long-term goal of the project will be to use the information to inform interventions and policy to improve the experience of grand parents, siblings and CSHCN.

Student Involvement: Bridget Fredericks is a Marquette University undergraduate nursing student and a co-investigator. She will participate in the focus groups, transcribe the audio taped interviews and assist with the themes, conference abstract and manuscript writing, while studying abroad in Dublin Ireland in the Spring semester 2018. Dr. Norah Johnson will be the PI, and serve in a mentorship role in the project, develop the focus group questions, recruit and lead the focus group of parents (n=5-8), with assistance of Dr. Brenner.

References: 1. Elias, E. R., Murphy, N. A., & Council on Children with, D. (2012). Home care of children and youth with complex health care needs and technology dependencies. *Pediatrics*, 129(5), 996-1005. doi:10.1542/peds.2012-0606
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Keywords: Children, Health, Ireland

Project Title: Mariano of Florence and Religious Life in Cinquecento Italy

Faculty Name: Lezlie Knox, Associate Professor, History

Introduction: What physical objects characterize a scholar? For modern humanists, shelves crammed with books or stacks of papers teetering on a desktop remain common markers. We read these texts for their information and debate their arguments in our own writings. For even as digital texts and databases are increasingly important, a physical library marked by sticky notes, dog-eared pages, and scrawled marginalia persists. The book collection thus embodies intellectual curiosity and scholarly methodology.

Significance: My project seeks to identify the books used by Fra Mariano of Florence (d. 1523), the subject of my own current book project. Mariano was a prolific author who wrote histories of his own Franciscan movement and native Tuscany, as well as pilgrim guidebooks. Although he lived during the first century of the printed book, none of his own writings were published during his lifetime and they mostly survive in unique manuscript copies. I have now had the opportunity to see all of these manuscripts, but the process of examining them has raised new questions about the texts to which Mariano had access for his research. I have identified two works that he owned (one printed, the other manuscript), but he mostly would have drawn from the community libraries as he moved between friaries in central Italy. I am using catalogues of various archival collections to build a list of manuscripts associated with these communities and intend to examine these books on my next research trip to Italy. I am interested not only in their contents-basically what the texts are-but especially in how the physical manuscript reflects a history of reading through notes, evidence of wear, and basic organization of texts. Reconstructing these libraries will allow me to build an intellectual profile of Mariano and his fellow Franciscan friars and sisters, thus deepening my understanding of their concerns.

Innovation/Forward Thinking: These manuscripts are housed in various public and private archives in central Italy. None have been digitized (i.e. scanned and made available on the internet), so it is necessary to travel to these locations to examine them. While I am able to use some electronic resources such as CODEX: Inventario manoscritti medievali di Toscana (Inventory of Medieval Manuscripts in Tuscany) to identify manuscripts once owned by these friaries, my own previous research in Florence has confirmed both that not all manuscripts have been catalogued and that these brief entries do not identify all marginalia or similar evidence for reading patterns, much less evidence for the process of composition. For example, my favorite page in one of Mariano's autograph manuscripts includes a note from him that the text should not be read aloud since he was not done revising it! Funds will be used to support a short research trip to Italy (May or June 2018) during which I will examine manuscripts identified as belonging to Mariano of Florence or the communities in which he lived. Funds will be used for travel (bus, plane, train) as well as lodging. My preliminary list of archives includes collections in Florence, Pistoia, and Pisa.

References: 1. Alison Frazier, ed. *The saint between manuscript and print: Italy 1400 1600* (Toronto, 2015).
2. Neslihan Senocek, "The Circulation of Books in the Medieval Franciscan Order: Attitude, Methods, and Critics," *The Journal of Religious History* 28 (2004): 146-161
3. K.W. Humphreys, ed. *The Friars' Libraries* (British Library, 1990)

Keywords: Medieval/Renaissance history, manuscripts, Italy, religious culture

Project Title: Effective point-of-care (POC) molecular detection and determination of prevalence of malaria and schistosomiasis co-infection in pregnant women from two districts of Ghana

Faculty Name: Nilanjan Lodh, Assistant Professor, Clinical Laboratory Science

Student Name: Miriam Price, Mary Thao

Introduction: In sub-Saharan Africa, a significant proportion of the population are exposed to malaria, schistosomiasis and soil transmitted helminth infections (STHs) [1]. It is estimated that over a third of the world's population is infected with parasitic helminths and Plasmodium species in the tropics and sub-tropics. Most importantly, about 40 million pregnant women are infected with STHs and Schistosoma spp. globally [2]. Infections caused either by STHs or by schistosomes remain among the neglected tropical diseases (NTDs), posing major public health problems in sub-Saharan Africa. When parasitic diseases overlap in distribution, high rates of co-infection occur. Such is the case in Ghana; however, published data on the effect of helminth infections on pregnant women in Ghana are not extensive. In addition, no study to date has assessed the prevalence of schistosomiasis and STH infections along with malaria in pregnant women and the impact of co-infection on the acquisition of immunity to placental malaria.

Significance: The project is designed to address weaknesses in the current diagnostic techniques available for malaria, schistosomes and STHs and optimize them for use in determining the prevalence from single non-invasive sample source and ultimately use these tools in clinical and field setup. The proposed diagnostic is the target of a major mass treatment program, which will address issues including sensitivity, specificity and logistics surrounding sample collection and handling. However, standard diagnostic procedures such as rapid diagnostic tests (RDTs) for malaria, parasite egg detection in stool by Kato-Katz (KK: WHO recommended) for *S. mansoni* and hookworms lack sensitivity and hematuria (blood in urine) for *S. haematobium* and various culture methods for detecting *S. stercoralis* larva in stool lack both sensitivity and specificity [3]. The prevalence of these parasites and co-infection particularly in pregnant women, is underreported largely not only because of the reason that the standard examination procedure using stool is relatively insensitive, but also due to the fact that reliable, ready-to-use and low-cost diagnostic tool to identify infected patients is not available. To evaluate surveillance and control programs, more sensitive and specific tests need to be introduced.

Innovation/Forward Thinking: The proposed work will be done at Marquette University under supervision of Dr. Lodh, and will provide an optimum situation to examine co-infection rates and prevalence in the North and Central Tongu districts of the Volta region of Ghana. We have developed highly sensitive diagnostic methods based on a single urine specimen from which *P. falciparum* as well as *Schistosoma mansoni* and *S. haematobium*, Hookworms and *Strongyloides stercoralis* DNA [4-5] will be detected using non-invasive urine samples. In collaboration with Ghana we will determine a) the nature and extent of mixed infections in two districts of Ghana and b) determine the distribution and prevalence in pregnant women as high parasite level vs. low parasite level. Such a groundbreaking study could be beneficial for the target population in endemic countries for maintaining a healthy, sustainable family and community life. This will be an important addition to the planning and implementation of disease interventions and control priorities.

Student Involvement: Currently two undergraduate students are involved in this project. More students will join from Spring 2018. Undergraduate students will be involved in the laboratory work, handling data and working on analysis and presenting outcome of the study at the national and international meetings and conferences.

References: 1. Brooker S, Akhwale W, Pullan R, Estambale B, Clarke SE, Snow RW, et al. Epidemiology of plasmodium-helminth co-infection in Africa: populations at risk, potential impact on anemia, and prospects for combining control. *The American Journal of Tropical Medicine*.

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Keywords: Co-infection, Filtered urine, LAMP, Molecular diagnosis

Project Title: Recordando a Madre Rosa: Oral Histories of a Marquette Doctor in Highland Guatemala

Faculty Name: Laura Matthew, Associate Professor, History

Student Name: Colin Caley, Angel Fajardo, Ricardo Fernandez

Introduction: Between 1962 and 1992, Marquette graduate and Maryknoll sister Rose Cordis (Dorothy) Erickson and Milwaukeean Maryknoll Jane Bullerbach built a 50-bed hospital, eighteen clinics, and nurse training programs that had served 12,686 inpatients, 475,889 outpatients, and immunized 182,117 children in the remote Guatemalan town of Jacaltenango (Fitzpatrick 2010). It is no exaggeration to say that Madre Rosa is considered a saint in the town. Madre Juana, now aged 87, is also a venerated and beloved figure. "Recordando a Madre Rosa" is an oral history project to record, archive, publish, and analyze interviews of the local health care workers trained by Madre Rosa and Madre Juana. We will build a transnational team that includes community members in Jacaltenango, and carry out the interviews beginning Spring Break, 2018. In collaboration with our Guatemalan partners, we aim to produce a bilingual history that makes the health care workers' memories of Madre Rosa, Madre Rosa, and the Jacaltenango hospital's beginnings accessible to the Marquette and Jacaltenango communities alike, in English and Spanish.

Significance: A short biography of Madre Rosa has been written in Spanish (Delgado Camposeco and Jimenez Camposeco 1986). A few scholars have written about the Maryknolls' impact on the town in the context of religious evangelization and interethnic relations (Fitzpatrick 2010, Montejo n.d., Watanabe 1992). Today, however, a generation of local men and women who were trained by Madres Rosa and Juana and who implemented their regional health care program are entering old age. We believe that the memories of these health workers are an important historical resource that can capture the local, *human* experience of Madre Rosa's and Madre Juana's work during a thirty-year period marked by counterinsurgency war and economic modernization. Research in the Maryknoll archives and scholarly literature will help us contextualize the interviews.

Innovation/Forward Thinking: The most important aspect of this project is its collaborative nature. We seek not only to share the results of our work with the Jacalteko community, but to partner with them in its production. The final product may take one or several forms, including a bilingual article in the College of Arts and Sciences magazine, a website, a podcast, a pamphlet, or some combination. We will archive the interviews at the Museo founded by Madre Rosa and still maintained in the Jacaltenango hospital, and at Raynor Libraries Special Collections

Student Involvement: This project is student-run. While we depend on the previous experience and contacts (including potential team members in Jacaltenango) of our faculty adviser and decisions will be made as a team, the creative work, research, organization, and execution of the project will be the students'.

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Keywords: Guatemala, Health Care, Oral History, Maryknoll

Project Title: Vision-based analysis of Activity of Daily Living in a Hospital Discharge Facility
Faculty Name: Henry Medeiros, Assistant Professor, PhD, Electrical and Computer Engineering
Student Name: Philippe Ambrozio Dias

Introduction: Frailty is a condition of increased risk of negative health outcomes (e.g. hospitalization and death), due to physical, cognitive, and/or social impairments. Frailty indices combine information about the clinical, cognitive, functional, nutritional, and social skills and are computed based on questionnaires as well as clinical exams and performance tests (Pilotto et al., 2008).

Significance: With the rapid population aging occurring worldwide, there is increasing interest in estimating the health status and frailty of the elderly. However, no current technology allows the monitoring of geriatrically-relevant parameters unobtrusively and over long periods of time.

Innovation/Forward Thinking: International Component: Together with physicians from the Galliera Hospital (Genoa, Italy), our collaborators from the University of Genoa have designed a two-bedroom protected hospital discharge facility, equipped with video cameras and other sensors arranged to enable an unobtrusive monitoring of patients. Our long-term goal is to create video analytics tools to generate, unobtrusively and accurately, automatic Activity of Daily Living (ADL) analysis reports that can be used by geriatricians to evaluate the overall health status of patients. Existing techniques for semantic segmentation present limited performance in our application, since objects of interest may appear in different parts of the image, at different scales, poses and deformations. We plan on fine-tuning current approaches to perform view-specific segmentation, incorporating as well temporal models that predict the expected position of objects across frames (Dias, Medeiros, & Odone, 2017).

Student Involvement: Prof. Francesca Odone (University of Genoa, Italy) and Prof. Henry Medeiros direct the research project. Philippe Dias is working on the implementing and evaluating of semantic segmentation algorithms for video-based ADL analysis.

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Keywords: Frailty estimation, Deep Learning, Semantic segmentation, Multi-target Tracking

Forward Thinking Posters

Project Title: Identifying Gesture Patterns to Predict Risky Behavior Among Veterans with PTSD

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science

Student Name: Tanvir Roushan, Md Fitrat Hossain

Introduction: In recent studies the Veteran Affairs (VA) has started to define PTSD by its association to specific high-risk behaviors rather than defining PTSD based on a cluster of psychiatric symptoms. Some researchers have suggested that high risk behaviors -- extreme anger (i.e., rage or angry outbursts) is particularly problematic within the context of military PTSD.

Significance: Accelerometer readings from wearable device (E4) were collected and mapped them with the gestures of the individual. Then the physiological data was cleaned and normalized to mark the gesture event with the time-stamps captured. Using clustering models and algorithms like EM clustering algorithm and Random Forest Classifier, we will classify a set of 12 gestures from the accelerometer readings.

Innovation/Forward Thinking: From results found, we can say that our model is efficient in determining five gestures based on accelerometer data. Once we have more data from multiple subjects, we should be able to detect 12 gestures. Forward thinking aspect in this project is we will combine the other physiological data like electrical conductivity of the skin, blood pressure and heart rate, we look forward to detect risky behaviors beforehand and intervene.

Student Involvement: This project presents the analysis of the gesture patterns of an individual that represents risky behavior to determine their activities. We find that 82% of times our classification model identified five gestures based on accelerometer readings correctly.

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Keywords: Gesture analysis, Veterans, wearable devices

Project Title: Non-Invasive Human Identification Using Wifi Signals

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science

Chandana Tamma, Adjunct Assistant Professor, Electrical And Computer Engineering

Student Name: Riddhiman Adib, Jannatul Ferdause Tumpa

Introduction: We commonly encounter the process of human identification and detection of their presence in certain events. A few common examples would be detecting the identity of students present in a classroom, or detecting if a certain patient has checked into the hospital or not. This is a fairly common problem, and we generally follow the trivial solutions to this problem, as for example, using student id card to swipe, or checking in at the reception at the medical center. The issue with all these existing procedures is that all of them requires some action by the human himself as well as being invasive of the privacy of the person. In this research proposition, we are planning to come up with a solution that can detect and identify human as an individual, and also will require no action from the person itself as well as will not disclose any private information of that person to the system. And to do all of that, we will be using Wifi signals and leveraging the effects wifi signals face due to human presence in a specific environment. Wifi signal has already shown great promises in sensing human activity in probability based models as well as crowd-based models (Guo, et.al., 2016). Wireless signals, in the form of Wifi, are now commonly found everywhere in our lives, from offices, schools, medical centers, shopping malls to our homes. We plan to leverage this presence of wifi signals all around us and will be trying to use it as a tool to detect human presence and identify them as separate individuals.

Significance: Very recently, different research work has actively used wireless signals to detect different human activities and motion in the form of wifi. Commercial wifi devices have been used to recognize human activity with up to 96% accuracy (Wang, et.al., 2017). Wifi has been used to detect human emotion as well from RF signals reflected off the human body (Zhao, et.al., 2016). We plan to work on these and extend these works to unique human detection. Generally, when we intend to ensure a person's presence, we engage two most commonly used approaches Regular approach to human identification requires either visual aids, like using image and video detection tools, like security camera, surveillance camera, or requires using physical acts, like using id cards to swipe or using fingerprints or using voice commands. Our approach would propose a solution where the person won't even need to connect to the wireless local network or use any other application, simply the presence and activity movements of him should be enough to detect his presence in a closed environment.

Innovation/Forward Thinking: The research field of human identification with the aid of just wifi signals is relatively newer and smaller. It has been applied to detect human gestures (Pu, et.al., 2013) as well as capture human figure (Adib, et.al., 2015). We plan to move forward with this research project in a direction where we will incorporate machine learning for the detection system, that will improve over time with increasing training data. The forward-thinking in our proposition would be: 1) detecting and identifying human as an individual by their own unique id just using wifi signals, 2) using a non-invasive approach, 3) separating human movement/presence from that of a non-human (e.g. pets or cars or robots), 4) applying machine learning to improve the system over time.

Student Involvement: Riddhiman Adib: will mostly read through the background study along with the other student partner, plan on how to approach the problem, finding the appropriate IoT modules and setting them up, collect data, apply noise removal algorithms as well as other signal processing algorithms (if needed), analyse the dataset, come up with a mathematical model with error analysis etc. Jannatul Ferdause Tumpa: will read through the background study along with the other student partner, come up with the mathematical model for the dataset, help with setting up the system as well as necessary programming support needed for the environment to work properly, etc.

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Keywords: Human identification, Security privacy, Wireless signal, Internet of things

Project Title: Develop a Conversion Matrix Using Hyperspectral and RGB Data for Noninvasive Hemoglobin Level Measurement

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics and Computer Science
Young L. Kim, Professor, Biomedical Engineering, Purdue University
Md Munirul Haque, Research Scientist, Center for Healthcare Engineering, Purdue University
Student Name: Md Kamrul Hasan, Jordan Trinka, Michelle A. Visbal Onufrak

Introduction: Hemoglobin (Hb) level detection is important for diagnosis and triage of multiple medical conditions including sickle cell anemia and chronic anemia. Besides clinical Hb measurement method, shining a light through a small volume of blood, spectroscopic analyses of light absorption of Hb are also used to quantify Hb content [1]. Hb has a unique characteristic absorption spectrum in the visible and NIR range that can be measured by a spectrometer, or an imaging spectrograph. But, the limitation on image acquisition and processing time of the spectral data using those devices hinder the development of a cost-effective imaging system. For this reason, we aim to investigate whether it is feasible to determine spatial and temporal changes in Hb content computed from RGB images without using a bulky hyperspectral imaging system using a smart conversion matrix. We have observed the mathematical reconstruction of hyperspectral imaging from RGB image data using a conventional 3-color (RGB) camera that was applied recently in many biomedical applications [2]. Taehoon et al. used a mathematical hyperspectral reconstruction process from RGB images using transfusion matrix in a simple imaging setup to visualize the hemoglobin content in a mice skin [3].

Significance: In the US about a hundred thousand people suffer from SCD. Among the patients, about 99% are African Americans. About 22% of the patients who reported severe pain die during a pain episode. The long-term goal of this research is to develop non-invasive, easy-to-obtain smartphone based point of care (POC) tool to measure the Hb level of an adult with SCD at home. Providers who triage calls from ill patients could make the decision on objective data transmitted from the phone and could reduce many unnecessary admissions to the ED.

Innovation/Forward Thinking: Lower eye-lid palpebral conjunctiva is an important location to get the human biomarker information to the physicians. We found that various researchers used visible range diffuse reflectance spectra [4], RGB image [5] of lower eye-lid to calculate the Hb level. Here, we aim to use lower eye-lid RGB image as input and develop a reconstruction algorithm for generating a full spectrum information of eye-lid image using a transformation matrix. We will use the spectral response of the 3-color CCD sensor and RGB signals to develop the transformation matrix (T). After building the T , we can measure the reflectance spectra (R) of the RGB image (X) using $Rm^T = X$. We break down the $RGB-T$ matrix multiplication into many matrix-vector multiplications and we use a Monte Carlo method in order to find a close approximation of each column vector in the right-hand side matrix. So, each iteration, we right multiply the RGB matrix by a 3 by 1 column vector whose entries are, uniform, 0 to 1, random numbers and we measure the Euclidean distance between the resulting vector and the right-hand side column vector which we are trying to approximate.

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Keywords: Noninvasive hemoglobin measurement, Conversion matrix, RGB to hyperspectral, Smartphone based hyperspectral data

Project Title: E-Spectrum: An Endeavor to Continuously Detect Emotional States and Iteratively Learn Emotional Perception Unique to the Individual

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics, and Computer Science
Amy Van Hecke, Associate Professor, Psychology

Md Munirul Haque, Research Scientist, Center for Healthcare Engineering (RCHE)

Student Name: Piyush Saxena, Nazmus Sakib, Devansh Saxena

Introduction: We are surrounded by the IOT web where our physical interactions with the digital world are used to predict our actions to some extent. Most of these predictions are centered around the physical world, such as activity recognition and fall detection. In this proposed study, we will focus our attention on the psychological world and emotional state of the individual [2].

Significance: The specific aim of this research is to predict not only the dominant emotional state but also the composition of the emotional state using the data collected from an experimental study (according to the research plan) where we will record physiological sensor data as well as survey results. This research has a strong potential to make an impact in the domain of autism care and the mental health research.

Innovation/Forward Thinking: The uniqueness and novelty of this research are considering the variability in perception amongst individuals and the overlap of emotional states in an individual. For this purpose, we plan to conduct an experimental study on significant numbers of participants-assuring the participants' consent and maintaining proper privacy. Then, we will induce specific emotions using audio-visual stimulus and collected physiological data, including heart rate, blood volume pressure (BVP), inter-beat interval (IBI) and electrodermal activity (EDA). Besides that, for this study, we will integrate self-reports indicating the levels of 6 emotional states, Amusement, Anger, Sadness, Disgust, Fear and Neutral. Additionally, we will record a self-reported score for Anxiety. Then we will use the collected data to create a model to identify the dominant emotional state and the emotional spectrum (levels of emotional states) of an individual. The collected self-report will be used to account for variability in emotional perception (the same stimulus may induce different emotional responses in different individuals) and generate an emotional spectrum unique to the individual. Finally, we plan to come up with the design and implementation of a real-time application with an iterative learning module for the prediction of the dominant emotional state and the corresponding emotion spectrum, unique to an individual's emotion perception [1-3].

Student Involvement: Student Involvement is an integral part of the research and scientific investigation. Here, under supervision of the distinguished faculty members, the students will be involved in designing the research setup, collecting data, analysing data, sharing their insights from the analysis with both of the computer science experts and psychology specialists, validating the results from statistical point-of-view, conducting research to make significant impact on autism care using this validated findings and insights from data, and developing the real-time application for iterative learning.

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Keywords: Affective Computing, Emotion Modelling, Human-centered Computing, Situation Awareness

Project Title: Novel Image classification using Hybrid Feature Space: A Step to Enhance the Machine Vision

Faculty Name: Sheikh Iqbal Ahamed, Professor, Mathematics, Statistics, and Computer Science

Student Name: Piyush Saxena, Nazmus Sakib, Devansh Saxena

Introduction: In general, humans perceive an object using colors, dimensions, geometry, and any textual information they gather. Among that four information, most of the current image recognition algorithms rely exclusively on the first three and do not use the textual information for this purpose. This research idea-comparing to mimicking the human perception in recognizing object- is to develop and test an approach that allows for the inclusion of the text features in the learning algorithm to improve the recognition accuracy [2].

Significance: The specific aim of this research is to considerably improve the accuracy of the existing image recognition by leveraging text features from the images. For robust image prediction, image features and text features from optical character recognition (OCR) are combined to create a hybrid classifier. This novel image classification using hybrid feature space has a strong potential to improve the machine vision and recognition.

Innovation/Forward Thinking: The uniqueness and novelty of this research are from two aspects. First, it re-encodes based on a text-based feature space. This feature space has unique properties. In the case of evaluating this approach, it will perform as well as the state-of-the-art Convolutional Neural Networks (CNN) while training a classifier on a 15-dimension feature space compared to a 1000's of dimensions in the CNN. This will indubitably lead to a significant computational efficiency (both in training times and prediction speeds). The second one is the higher Information hybrid feature space: the addition of the text-based features leads to a statistically significant information gain creating a classifier that boosts the classification accuracy of the state of the art image classification algorithms including neural nets and critical point extractors [1-3].

Student Involvement: Student Involvement is an integral part of the research and scientific investigation. Here, under supervision of the distinguished faculty members, the students will be involved in designing the research setup, collecting data, analysing data, sharing their insights from the analysis, validating the results from statistical point-of-view, conducting research to make significant impact on different domains using this validated findings and insights from data.

References: 1. Donahue, J., Jia, Y., Vinyals, O., Hoffman, J., Zhang, N., Tzeng, E., & Darrell, T. (2014, January). Decaf: A deep convolutional activation feature for generic visual recognition. In International conference on machine learning (pp. 647-655).

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Keywords: Machine Learning Classifier, Hybrid-feature Augmented Space, Text-based Feature Space, Convolutional Neural Network

Project Title: Expression and Relevance of VEGF-A in Condylar Hyperplasia

Faculty Name: Luis Almeida, Clinical Assistant Professor, School of Dentistry - Oral Surgery

Student Name: Seth Butcher

Introduction: The aim of this study is to determine changes in expression of vascular endothelial growth factor (VEGF-A) in the condylar hyperplasia (CH) disease state via immunohistochemical staining (IHC) in order to better understand the etiology of the condition and therefore be able to develop treatment modalities other than surgery. CH is a disease characterized by significant unilateral metabolic activity and growth of the mandibular condyles. To date, the etiology of CH has yet to be determined, but has been linked to abnormal endocrine or metabolic function, trauma, arthrosis, and genetics (Almeida et al., 2015). Histologically, CH is characterized by rapid expansion of the mesenchymal layer of the affected condyle with extensive proliferation of chondrocytes (Eslami et al., 2003). VEGF-A is an important signal protein involved in angiogenesis and has been implicated in the development of several similar osseous tumors (Han et al., 2016). Recent publications have suggested a link between CH and several growth factors, including VEGF-A (Guo et al., 2016).

Significance: Current knowledge on the etiology of CH is sparse and treatment options are strictly surgical. Current treatment usually consists of waiting for cessation of growth, followed by surgical removal of excess condylar material, approximation of remaining bony fragments, and subsequent orthodontics for correction of occlusion (Villanueva-Alcojol et al., 2011). CH presents functional and esthetic complications that are allowed to run their full course before intervention is attempted. At present, no pharmacological nor conservative approaches have been found suitable for the management of CH. By better understanding the disease we are combatting, additional treatment modalities may be developed.

Innovation/Forward Thinking: IHC is an excellent tool for studying the expression of various biomarkers within tissue samples. To date, no study has studied the expression of VEGF-A within condylar tissues. The protocol for this study has been developed and small scale trials have been performed with differences noted in the intensity of staining between the control and CH groups (n= 17). This study benefits from having samples from healthy patients, which are normally difficult to obtain, thereby improving the study design and allowing for more significant results. Knowing the etiology and pathology of a disease is critical in effectively managing the condition and developing novel treatment modalities.

Student Involvement: Seth, Adam, and Timothy are predoctoral students at the Marquette School of Dentistry. They have been tasked with developing the protocol, performing the trials, analyzing the results, and writing the forthcoming publication, all with the mentoring of Dr. Almeida.

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Keywords: Condylar Hyperplasia, Vascular Endothelial Growth Factor, Immunohistochemical Analysis, Etiology

Project Title: Immunohistochemical Expression of RUNX2 in Condylar Hyperplasia

Faculty Name: Luis Almeida, Clinical Assistant Professor, School of Dentistry - Oral Surgery

Student Name: Adam Sorenson

Introduction: This study aims to determine the relationship between runt-related transcription factor 2 (RUNX2) expression and condylar hyperplasia (CH). CH is defined as excessive unilateral growth of the mandibular condyles, leading to facial asymmetry with esthetic and functional complications (Elbaz et al., 2014). The etiology of CH is poorly understood, but has been shown to be associated with localized trauma and infection (Almeida et al., 2015). RUNX2 is a signalling molecule essential for the differentiation of osteoblasts and physiologic morphogenesis (Hakelien et al., 2014). Several recent publications have shown that increased RUNX2 expression is associated with hyperplastic osseous conditions, and it would seem evident that CH would be another such example (Del Mare et al., 2011). Our study uses immunohistochemical staining (IHC) to determine the level of expression of RUNX2 in our control and CH samples (n = 17). Preliminary staining has shown a difference in staining between the control and CH groups, with greater stain intensity in the CH samples. Further research is required to elucidate the etiology of CH, which includes a better understanding of the role played by RUNX2.

Significance: CH is a poorly understood condition with few treatment modalities. Current treatment is centered around waiting for growth cessation, surgical intervention, and subsequent orthodontics (Villaneuva-Alcojol et al., 2011). In order to better treat this condition, a more thorough understanding of the etiology and pathology is required. The results of this study may allow a clearer mechanism for the generation and propagation of the disease to be developed.

Innovation/Forward Thinking: This study uses healthy condyles from non-affected individuals as controls, which are normally difficult to obtain. Having such samples allows for better study designs and more significant results.

Student Involvement: Adam, Seth, and Timothy are predoctoral students at the Marquette School of Dentistry. Their responsibilities include development of the protocol, performing IHC trials, analyzing the results, and writing the subsequent publication. Dr. Almeida has played a strong mentoring role for the dental students.

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Keywords: Condylar Hyperplasia, Runt-related transcription factor 2, Immunohistochemical analysis, Etiology

Project Title: Theoretical and computational studies of spectroscopy and dynamics of elemental sulfur molecules

Faculty Name: Dmitri Babikov, Professor, Chemistry

Student Name: Igor Gayday

Introduction: Atmosphere is a crucial part of any ecosystem. All the living beings interact with it and their biochemistry depends heavily on the exact composition and concentration of the constituent gases. But these things are not carved in stone, they change substantially as the time goes by due to various processes. These changes have great effect not only on the living beings but also on the very geological processes that govern Earth's development, therefore understanding the dynamics and evolution of the atmosphere may give us valuable insights that will help us understand the past and the future of many ecosystems.

Significance: Recent studies have shown that polysulfur species constituted a sizeable part of Earth's atmosphere before oxygenation and were involved in many important atmospheric reactions. Furthermore, they still play a large part in the atmospheric chemistry of other planets – including not so distant ones – such as Venus. Here we focus on one of these species, namely S₄, also known as tetrasulfur. Our goal here is to compute accurate vibrational spectrum and corresponding wavefunctions. The spectrum itself is valuable for spectroscopic purposes as it allows to identify tetrasulfur presence among other species. In addition to that, this spectrum can be used to derive other important quantities such as lifetime and formation reaction rate constants.

Innovation/Forward Thinking: Previous studies revealed many properties of S₄,³ however, in order to calculate vibrational wavefunctions and corresponding energies, we need a complete global potential energy surface (PES). As the first step towards this goal, two-dimensional ab initio model of the PES was obtained at CCSD(T)-F12/cc-pVTZ-F12 level of theory (Fig. 1). The resultant PES is in the good agreement with the one obtained by Matus et al. Low-lying vibrational states are computed using a theoretical framework described by Teplukhin and Babikov.

The next step to improve the accuracy of our predictions is to remove some of the constraints of our model and allow an additional degree of freedom. Normal modes analysis showed strong coupling between the two bending angles so we need to let the molecule to bend independently in both directions. After that lifetimes and formation reaction rate constants can be computed.

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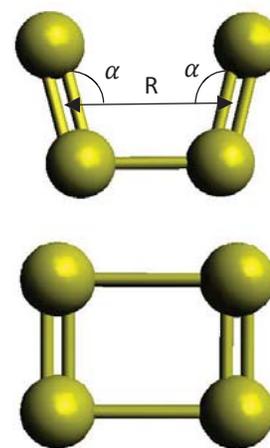


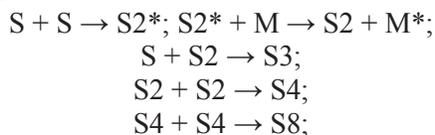
Figure 1. Minimum energy point structure (C_{2v}) and transition state (D_{2h}) of tetrasulfur.

Project Title: Theoretical/Computational Studies of Energy Transfer in Molecules Relevant to Planetary Atmospheres

Faculty Name: Dmitri Babikov, Professor, Chemistry

Student Name: Bikramaditya Mandal

Introduction: Sulfur is one of the elements, which plays key role in the cycle of matter on our planet, Earth. It has significant role not only for Earth, but also for the atmosphere of Moon, other planets, such as Venus, and shells of some stars. It takes part in volcanic eruptions, microbiological respiration processes, water evaporation, decaying of organisms, and some industrial processes. During the period of volcanism billions of years ago, huge amount of sulfur compounds were injected into the atmosphere which left traces found in several minerals like nitratine, barite, gypsum, and pyrite. There exist four isotopes, ^{32}S , ^{33}S , ^{34}S and ^{36}S that indicate the importance of isotopic effects. The recombination reaction of sulfur is very important in this context. Stable sulfur atoms combine and form S_2 . Furthermore, it can combine with elemental sulfur atom or with other allotropes to form S_3 , S_4 , S_8 that S_8 is the most abundant allotrope of elemental sulfur found in Earth. This analysis is very important to analyze evolution of life and atmosphere of Earth or other planets. The recombination reactions are as follows:



Significance: We started with the smallest sulfur allotrope, S_2 . Analysis of the metastable disulfur colliding with a bath gas atom (M) is very important to find recombination rate of sulfur allotropes. We chose noble gas, Argon to collide with disulfur. We need to do electronic structure calculations and analysis of the structure, vibrational frequencies, and isotopic shifts of the system $\text{Ar} + \text{S}_2$ to understand recombination reactions.

Innovation/Forward Thinking: Currently we are doing electronic structure calculations of $\text{Ar} + \text{S}_2$ system, which will be followed by the calculation of rotationally inelastic scattering cross section computation. This computation cannot be done classically as the classical description is not always correct and full quantum calculations for this heavy system is computationally very demanding. So Mixed Quantum/Classical Theory will be used where translation motion or scattering will be treated classically and rotation and/or vibration (internal motion) will be treated quantum mechanically. Finally, vibrational inelastic cross section will be computed and will be used to analyze recombination rate constant for sulfur allotropes.

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Project Title: Pediatric Assessment of Speech Breathing in Neuromuscular and Musculoskeletal Disorders

Faculty Name: Jeff Berry, Associate Professor, Speech Pathology & Audiology

Bridget Valla, Clinical Assistant Professor, Speech Pathology & Audiology

Student Name: Laura McCormick

Introduction: In the field of Speech-Language Pathology many researchers have focused on establishing methods to assess a child's speech by analyzing the movements of the tongue, lips, and jaw. While characterizing the movements of these structures is important in many clinical cases, understanding the details of speech-related breathing is often equally important in guiding effective therapy [1]. While there are well-established methods for assessing speech breathing in adults, there has been substantially less effort to standardize such clinical assessment in pediatric populations [2]. The purpose of our study is to help standardize methods for assessing speech breathing in kids with neuromuscular musculoskeletal disorders and provide much needed preliminary data on the effectiveness of treatment techniques [3]. Children with neuromuscular disorders such as Cerebral Palsy often have speech breathing disorders [3]. A speech breathing disorder is an abnormality in the process of supplying the air needed for speech production. It results from an abnormality in the control or structure of the chest wall system which includes the ribcage, diaphragm, and abdominal wall. Kids with neuromuscular and musculoskeletal disorders tend to have difficulty coordinating the movements between these components of the chest wall system which decreases the amount of air they have available for speech. These challenges affect the loudness, naturalness, and overall intelligibility of speech.

Significance: Speech breathing disorders are common among children with neuromuscular and musculoskeletal disorders due to inspiratory/expiratory muscle weakness and incoordination [3]. Relatively little information has been published on the nature of speech breathing in children with neuromuscular and musculoskeletal disorders, in part due to a lack of standardized assessment techniques. Better identification of atypical patterns of speech breathing would assist in the evaluation of the effectiveness of treatment strategies.

Innovation/Forward Thinking: An inductive plethysmography system [4] that measures movements of the chest wall and abdomen during speech will be used to compare the speech breathing patterns of children with neuromuscular and musculoskeletal disorders to those of typical speech breathers. All of the children with neuromuscular and musculoskeletal disorders that will be assessed in this pilot study will be receiving treatments based on the Neuro-Developmental Treatment (NDT) approach. NDT treatments focus on postural control and alignment, as well as client-specific neuromuscular, musculoskeletal, respiratory, and sensory impairments. In addition to standardizing methods for speech breathing assessment, this project will provide a preliminary evaluation of the effectiveness of NDT .

Student Involvement: Laura McCormick has been working with Dr. Jeffrey Berry learning how to assess speech breathing using inductive plethysmography. This past summer she completed the Biomedical Sciences Summer Research Fellowship. Ms. Bridget Valla has been supervising Laura's assessments of various clients in the Marquette Speech and Hearing Clinic, and helping her take periodic measurements of the clients receiving Neuro-Developmental Treatment. Laura is also working with Dr. Berry on refining methods for analyzing these data using laboratory software [5]. She will continue serving as a clinical-liaison when pediatric speech breathing assessments are indicated and is working with her mentors toward establishing normative data for helping gauge the severity of speech breathing disorders by analyzing breathing patterns for typical kids and kids with neuromuscular and musculoskeletal disorders.

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Keywords: Speech Breathing, Neuromuscular Disorders, Pediatrics, Musculoskeletal Disorders

Project Title: Dynamic Behavior of Earth Materials Subjected to Rapid Pressure-Shear Loading

Faculty Name: John Borg, Associate Professor, Mechanical Engineering

Student Name: Jeff LaJeunesse

Introduction: The ballistic penetration of objects impacting both homogeneous and heterogeneous materials has been of interest to a variety of research fields ranging from defense applications to planetary science. A comprehensive understanding of these phenomenon involves characterizing the effect of high strain rate loading on the materials of interest. The United States Defense Threat Reduction Agency is interested in studying how granular earth materials, such as sand, responds to these types of dynamic loading resulting from high velocity impacts.

Significance: This work aims to characterize sand samples in a laboratory setting and use the knowledge gained to make predictions about large scale systems under dynamic loading. Examples of large scale systems include the detonation of buried improvised explosive devices, the lethality of penetration devices, and cratering studies for asteroid impacts. The first two examples represent common defense applications that could potentially help protect troops stationed abroad. The second example is extremely important in characterizing the surface composition of foreign planets, such as Mars, based on surface craters resulting from asteroid impacts.

Innovation/Forward Thinking: Dynamic loading of sand in a pressure-shear configuration has received little attention in the shock physics community and is far from understood. Collaborations will be made with Physicists from Sandia National Laboratories on experimental design and diagnostics as well as Planetary Scientists from UC Davis on understanding the implications of the results.

Student Involvement: The student will perform experiments in Marquette University's Shock Physics Laboratory with a light gas gun that accelerates projectiles up to 450 miles per hour before impacting sand samples of interest. Additionally, three-dimensional mesoscale simulations will be performed using United States Department of Defense high performance computing resources. The simulations will directly investigate the response of sand in identical configurations used in the experiments to further develop understand and modeling capabilities.

Project Title: SUPREME: A Cancer Subtype Prediction Methodology by Integrating High Dimensional Biological Datasets

Faculty Name: Serdar Bozdag, Assistant Professor, Mathematics, Statistics, and Computer Science

Student Name: Ziyet Nesibe Kesimoglu

Introduction: Cancer, the second leading cause of death in the world [1], is a complex genetic disease. Every cancer patient is unique in terms of progression of disease and response to treatment [2]. In recent years, vast amount of biological datasets from cancer tissues have been generated to better characterize the cancer biology. With these efforts, subtypes of some cancer types have been discovered [3, 4] and tools to predict the subtype of a new patient have been developed [5, 6]. Several of these studies relied on a single type of biological dataset such as gene expression [3], DNA methylation [4] and other tools attempted to integrate various datasets [6].

In this study, we aim to develop a cancer subtype prediction methodology called SUPREME that integrates multiple types of biological data to discover novel cancer subtypes, predict subtypes of cancer patients and discover subtype-specific biomarkers. We will test SUPREME on publicly available cancer datasets such as breast cancer dataset from the Cancer Genome Atlas Project.

Significance: SUPREME will be a user-friendly tool for biologists and clinicians to predict subtype of a cancer patient. SUPREME will report specific biological biomarkers associated with each subtype, which could shed some light on the mechanism of cancer initiation and development. SUPREME will allow users to cluster patients on multiple datasets simultaneously to potentially discover new subtypes. SUPREME will have two versions: a web tool and a standalone package.

Innovation/Forward Thinking: SUPREME will be a multi-purpose tool to study cancer and cancer subtypes. SUPREME will be flexible to integrate different types of datasets and handle the high dimensionality of datasets by applying feature selection methods. We will develop SUPREME using novel deep learning based algorithms.

Student Involvement: Ziyet will work on the computational experiments in this project under Dr. Bozdag's supervision.

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Keywords: Bioinformatics, Cancer Subtype Prediction

Project Title: An Integrated Framework for Identifying Context Specific Gene-Drug Interactions Among Cancer Patients: An Advanced Step Towards Personalized Medicine

Faculty Name: Serdar Bozdag, Assistant Professor, Mathematics, Statistics and Computer Science

Student Name: Banabithi Bose

Introduction: Cancer is one of the leading cause of death worldwide and according to the National Cancer Institute cancer deaths will be projected from 8 million to 13 million in the next two decades. Each cancer patient is unique and traditional clinical therapy "one-dose-fits-all" has proven having adverse effect in patient's health and survival [1]. A study on adverse drug reaction in US published that 67% of hospitalized patients including cancer patients are affected by the adverse drug reactions and for this reason the number of deaths exceeds 100,000 cases annually [2]. Thus, it is essential to make cancer treatment "personalized" to provide the proper treatment to the proper person at the proper time. Recent studies analyzed tissue specific genetic datasets to model drug response in cancer [3]. These studies suffer from the high dimensionality of datasets and low sample size and they are limited by the toxic effect of drug in patient specific context. The goal of this study is to develop a computational tool that integrates genomic, genetic and metabolomics datasets with clinical datasets such as drug toxicology to predict context specific drug response in cancer. This tool will be helpful in the application of personalized medication of cancer patients. This computational tool will be further evaluated by the new findings in personalized DNA biomarkers the role of which can be further studied for the prediction of the overall survival outcome of a patient. Incorporation of metabolomics and toxicology studies in cell line with cancer drug will be able to deal with toxicity effects which is the biggest challenge in personalized cancer treatment.

Significance: Biological processes are usually context specific. For instance, an effective drug in one context could be adverse or useless in another context. The proposed tool will be helpful in determining the drug response more effectively between different contexts such as in specific tumor and in stratified patients groups. The expected outcomes of this project such as accurate prediction of patient-specific drug response and the underlying biological bio-markers for the drug response will be beneficial in developing personalized cancer treatment.

Innovation/Forward Thinking: This study will be an integrative approach in personalized medicine where patient specific biological and clinical datasets will be leveraged to predict drug response. We plan to develop novel deep learning algorithms to analyze these high dimensional data and infer important insights in personalized medicine.

Student Involvement: This study is a part of the dissertation work proposed by Banabithi Bose who will be conducting the computational experiments.

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Project Title: Design Day Analysis: Forecasting Extreme Gas Demand
Faculty Name: Ronald Brown, Professor, Electrical and Computer Engineering
Student Name: David Kaftan

Introduction: Natural gas demand is primarily driven by temperature [2]. LDCs use daily average temperatures to characterize the Design Day demand scenarios. Design Day demand is associated with the coldest temperature that is exceeded once every N years (a typical value for N is 30). The daily average temperature associated with Design Day demand - known as Design Day conditions - are used to communicate with regulatory commissions. We therefore address two forecasting challenges. First, we must determine the Design Day conditions so that risk can be communicated to commissions. Second, we must forecast the Design Day demand to help LDCs plan.

Significance: February of 2015 was one of the coldest months in the history of Wisconsin [1]. While Wisconsinites turned up their thermostats, forecasters worked to predict the increased demand of natural gas. Failure to accurately predict the gas demand could have led to higher prices or - in the extreme case - people having their heat shut off. Local distribution companies (LDCs) of natural gas need to be prepared for days with extremely high demand. Such a day is known as the Design Day. This thesis explores the challenge of forecasting the Design Day.

Innovation/Forward Thinking: We invent new ways to model extreme cold temperatures. This includes resampling techniques and extreme value theory (EVT). We also better quantify uncertainty in our predictions of demand on extreme cold days.

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Project Title: Comparing Regenerative Abilities in New Caledonian Geckos

Faculty Name: Tony Gamble, Assistant Professor, Biological Sciences

Student Name: Aaron Griffing

Introduction: The capacity to regenerate damaged or lost appendages as an adult is not exhibited by the majority reptiles, birds, and mammal species (Carson, 2007). However, many lizards readily autotomize (voluntarily shed) their tails in response to attempted predation (Bellairs and Bryant, 1985), after which embryonic gene families are expressed, resulting in tail regeneration (Jacyniak et al., 2017). Though the regenerated tail does not possess some of the original elements of the tail (e.g. bony elements), it exhibits full regeneration of numerous important structures, such as blood vessels, nervous tissue, cartilage, and scales (Bellairs and Bryant, 1985; Jacyniak et al., 2017). However, some lizards have lost this ability. New Caledonian crested geckos (*Correlophus ciliatus*) successfully heal wounds following autotomy, but do not regenerate their tails past a small, knob-like tail bud. Sarasins' giant geckos (*Correlophus sarasinorum*), close relatives to *C. ciliatus*, retain the ancestral ability to regenerate their tails following autotomy. Because this loss of function has occurred in recent evolutionary history (~6–11 million years ago; Skipwith et al. 2016), *C. ciliatus* provides an "evolutionary knockout" to comparatively study the cellular and genetic changes that prohibit successful regeneration. Though extensive investigation has been placed on successful regeneration of lizard tails (Bellairs and Bryant, 1985; Jacyniak et al., 2017), there have been no studies on the loss of regenerative ability in lizards. The purpose of our study is to compare transcriptional activity and cellular composition between successfully regenerating tails and unsuccessfully regenerating tail buds.

Significance: Relative to lizards, most mammals, including humans, can regenerate very few tissues as adults. For example, human spinal cord injury is a persistent and difficult to treat condition (Kakulas, 1999). Understanding the mechanisms that prevents successful tissue regeneration in our lizard model may shed new light on aspects of our own biology, including our limited capacity for nervous tissue regeneration. As such, our proposed research has significant implications concerning human health and injury therapeutics.

Innovation/Forward Thinking: The loss of regenerative ability in *C. ciliatus*, which is analogous to the loss of regeneration in mammals, has yet to be studied. Using high-throughput transcriptome sequencing (RNAseq) and detailed morphological investigation (histology) in a novel comparative framework (*C. ciliatus* vs. *C. sarasinorum*), we will provide the first investigation of transcriptional activity and cellular organization in an unsuccessfully regenerating lizard.

Student Involvement: Aaron Griffing is a Ph.D. student who is advised by Dr. Tony Gamble. A portion of Aaron's dissertation focuses on lizard regeneration. He will be performing the majority of laboratory work, data analysis, and manuscript writing resulting from this study.

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Keywords: Evolution, Regeneration, Gene, Lizard

Project Title: Exploring Algorithmic Bias Through Crime in Milwaukee

Faculty Name: Shion Guha, Assistant Professor, Mathematics, Statistics and Computer Science

Student Name: Marielle Billig, Justin Miller

Introduction: Algorithms are becoming an increasingly popular tool for policy makers and other influential decision makers. The design of these algorithms, however, is often very opaque which leads to their misapplication. This project explored the ramifications of this misapplication regarding publicly available crime data from Milwaukee between the years of 2005 and 2016. Commonly used algorithms were deconstructed to find their inflection points where decisions were, or ought to be, made. By altering the decisions made at these inflection points, we were able to measure the bias introduced into the algorithm's design.

Significance: It is vital when designing algorithms to consider more than the end-user; oftentimes these algorithms can have a significant impact on the population being analyzed and by incorporating human-centered thinking into algorithmic design, we can create more ethical algorithms. According to a report using public data from the Wisconsin Department of Corrections performed by the University of Wisconsin-Milwaukee, approximately 50% of African American males in their 30s and 40s in Milwaukee County have been incarcerated. This type of disparity can be made worse by implementing clustering algorithms without fully understanding how previously held biases can affect the results.

Innovation/Forward Thinking: This is an area of continuing research. We have applied for external funding from the National Science Foundation and plan to expand the scope of this project over the next several months. Ultimately, we plan to deconstruct many other commonly used algorithms to determine if and how they also can be affected by bias.

Student Involvement: Much of this research took place over the summer of 2017 by undergraduates Justin Miller and Griffin Berlstein. Marielle Billig will continue the project throughout this year with a focus on addressing different algorithms. Dr. Shion Guha provided valuable guidance and mentorship throughout the entire process.

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Keywords: Algorithms, Ethics, KMeans, Crime

Project Title: Advances in D-bar Methods for Electrical Impedance Tomography

Faculty Name: Sarah Hamilton, Assistant Professor, Mathematics, Statistics, and Computer Science

Introduction: Electrical Impedance Tomography (EIT) imaging aims to recover the internal conductivity and permittivity distributions from electrical measurements taken at the surface of an object. The reconstruction task is a severely ill-posed nonlinear inverse problem that is highly sensitive to measurement noise and modeling errors (especially for traditional optimization methods). However, the EIT problem can be solved non-iteratively via D-bar methods, which have shown great promise in producing noise-robust implementable algorithms by employing a low-pass filter in a nonphysical scattering domain. The EIT problem, a generalized Laplace equation, is transformed to either the Schrodinger or DS-II equation(s) where the D-bar methods are then employed. The methods have the added bonus of being capable of recovering both time-difference as well as static/absolute EIT images.

Significance: Applications of EIT include monitoring heart and lung function, classification of cancerous vs. benign tumors, ischemic vs. hemorrhagic strokes, and nondestructive evaluation of concrete.

Innovation/Forward Thinking: This presentation focuses on how spatial information, known with high confidence a priori, can be directly incorporated into traditional D-bar methods for EIT. In particular, we demonstrate how including a spatial prior comprised of the approximate major organ locations in a healthy patient of similar size, greatly improves EIT reconstructions while still allowing underlying pathologies to be visualized in sick patients. Furthermore, these methods can be extended to limited boundary access scenarios; critically-ill patients can be imaged by only using the accessible part of their body (i.e. a partial boundary problem must be solved). Reconstructions from experimental tank data are presented and future directions discussed.

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Keywords: Electrical Impedance Tomography, Conductivity, D-bar, Imaging

Project Title: "Who Run the World, Girls!": The Effect of Music that Affirms the Self on Women's Quantitative Performance

Faculty Name: Simon Howard, Assistant Professor of Psychology, Psychology

Student Name: Mary Tait, Marielle Samii

Introduction: From an early age, men are socialized to be interested and consequently expected to aspire to engage in STEM professions while women are socialized to endorse more emotional intelligence related to liberal arts. It is these implicit stereotypes about men's and women's performance that reduce a female's engagement and expectations to excel in math and science related fields (Norsek et al., 2009). In a study by Spencer et al. (1999), male and female university students completed either an easy or difficult math test based on questions from the Graduate Record Examination (GRE), while both men and women performed equally on the easy math test, males performed significantly better than females on the difficult test. The discrepancy in performance is hypothesized to be "self threat," a concept that applies to the stress that individuals carry about confirming the negative stereotype in their group and facing discriminatory judgement. In the same study, researchers administered a second test that either increased or reduced the stereotype threat in the situation, females that were exposed to the group that revealed the test had no gender differences performed significantly better than the stereotype threat group (Spencer, et al., 2009). Further, the stress that surrounds confirming a negative stereotype and experiencing discrimination from this confirmed stereotype may suggest why women avoid careers in STEM. Self-affirmation theory has been used in various studies like Martens et al.'s study entitled "Combating stereotype threat: The effect of self-affirmation on women's intellectual performance." Within this study, women were found to have an increase in mathematic performance after participating in self-affirmation techniques (Martens et al. 2006). We will be utilizing a similar methods but instead of self-affirming by values like in Martens et al., we will be attempting to self-affirm through music that has lyrical content that is affirming of the female identity. This proposed study will recruit both men and women; however, the study will examine women's mathematical performance when posed with a stereotype threat after listening to either a neutral or self-affirming music condition in a threat non/threat condition. We hypothesize that women who have listened to music that affirms the female identity will lead to an increase in mathematic scores compared to women who listen to songs that are not affirming. Using music as a way to buffer stereotype threat is a practical way to buffer stereotype threat within the current generation of college students. Walking on a campus it is hard to find a man or woman not listening to music as they are walking to class, so it would be an easy and practical way for women to boost their performance in areas that are typically male dominated.

Significance: 1,637,589 high school students took the SAT test in 2016. On average, boys who took the SAT had an average math score of 542, while females had an average math score of 494. This discrepancy in scores has been shown each year the SAT has been administered ("SAT: The Total Group Profile Report," 2016). Even more concerning, women hold only 29% jobs within science and engineering workforce ("Statistics," 2017). If our results support our predictions, the implications of our work suggests that music may be used as a way to reduce these disparities within SAT test scores as well as the STEM workforce.

Innovation/Forward Thinking: The next step of our research would be to try to create a longitudinal intervention with women pursuing majors in STEM. Over the course of a semester we would track mathematical scores, GPA, and retention rates of women after implementing a regimen of listening to a song that has self-affirming lyrical content. No studies to date have ever used music as means to protect quantitative performance.

Student Involvement: Mary Tait (undergraduate) has been involved in the planning stages of the study as well as the dissemination of findings related to this project. Marielle Samii (undergraduate) has been involved in the planning stages of the study as well as the dissemination of findings related to this project.

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Keywords: Stereotype threat, Self-affirmation, gender, Quantitative performance

Project Title: Ambivalent Sexism and Attitudes Towards Gay Men vs Lesbian Women: Correlates of LGBTQ+ Representation

Faculty Name: Simon Howard, Assistant Professor, Psychology

Student Name: Samantha Conner

Introduction: Representation of sexual minority groups in media can either serve as an effective way to expose the general public to groups with whom they have limited familiarity. More exposure can result in increased tolerance toward unfamiliar groups; however, increased exposure may also have negative unintended consequences such as reinforcing stereotypes and prejudicial attitudes. The current study is interested in examining the relationship between exposure to varying representations of lesbian relationships, hostile sexism, benevolent sexism and attitudes toward gay men and lesbian women.

Participants will be randomly assigned to view one of two photos of a lesbian couple in wedding scenery. In one photo, the lesbian couple depicted will both have a feminine in appearance. In the other photo, one woman will have feminine appearance while the other will present as masculine. In the control condition participants will view photos of wedding scenery with no people present. After the viewing these images, participants will answer a series of surveys, including the Glick & Fiske Ambivalent Sexism Inventory, the Gay Men versus Lesbian Women Scale, and a series of demographic questions.

We hypothesize that participants exposed to the couple with two feminine appearing women will exhibit lower levels of hostile sexism, higher levels of benevolent sexism, and a larger discrepancy between attitudes towards gay men versus lesbian women when compared to the participants in the other two conditions. In addition, we hypothesize participants primed with the images of the couple with one more feminine appearing woman and one more masculine appearing woman will exhibit higher levels of hostile sexism, lower levels of benevolent sexism, and a smaller discrepancy between attitudes towards gay men and lesbian women when compared to the other two groups.

Significance: These results could potentially serve as a stepping-stone for action to be taken ensuring that LGBTQ+ relationships are accurately represented, and to emphasize the importance of ensuring minority representation.

Innovation/Forward Thinking: Future research should focus on the role of representation in forming long-term beliefs, and how that belief system influences behaviors and decisions such as voting patterns, or intervention in discrimination situations.

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Project Title: That's Unprofessional: The Effects of Hairstyle on Perceptions of Black Women's Employability and Professionalism

Faculty Name: Simon Howard, Assistant Professor, Psychology

Student Name: Jungwhan Cho

Introduction: Western beauty standards have permeated American culture for generations, creating unrealistic expectations for women of color and of different ethnicities. Namely, the view that Afrocentric hair texture being inferior to Eurocentric hair texture has dominated the American work place. African-American hair in its natural, afro-textured coiled or curly state gradually locks if allowed to grow without detangling or combing, thus requiring Black women to style their hair according to society's expectations. Additionally, Black women frequently experience a plethora of negative stereotypes associated with their natural hairstyles, which are often deemed as being 'unprofessional' or 'inappropriate' in the work place. For example, Black women have been fired from jobs for wearing their hair in braids or in dreadlocks. Despite numerous examples of discrimination faced by Black women for their hairstyle choice, empirical investigations on the topic remain scarce. The proposed study will explore implicit stereotypes associated with Black hairstyles and the effects those stereotypes have on Black women's employability through a LinkedIn experiment.

Significance: This study will measure participants' implicit attitudes toward different Black female hairstyles through a series of experiments. The study will demonstrate how implicit attitudes and negative stereotypes effect employment opportunities and perceptions of professionalism for Black women in the work place. Furthermore, the study will reveal how these implicit attitudes toward Afrocentric hair not only effect employability, but perceptions that may also effect criminal sentences in the court of law.

Innovation/Forward Thinking: Going forward, the proposed study will explore how implicit attitudes towards different Afrocentric hairstyles can affect employment opportunities and perceptions of professionalism for women of color. Additionally, we will further our understanding by measuring employability using a LinkedIn study. Through a LinkedIn study, we expect to see Black women who satisfy Western beauty standards to have better employment opportunities than Black women with natural, Afrocentric hairstyles. To date, the lack of empirical investigation on the topic suggests that there is still room for research in this understudied area of social psychology.

Student Involvement: Kalen Kennedy (graduate) and Jungwhan Cho (undergraduate)

Project Title: Application of Mechanical Vibration to Promote Osteointegration
Faculty Name: Dawei Liu, Associate Professor, School of Dentistry - Orthodontics
Student Name: Joseph Curry, Melanie Hammerbeck

Introduction: Today dental implants are commonly used in rehabilitating oral functions of patients with missing teeth. The fundamental principle of dental implants is called osseointegration – a process of direct structural and functional connection between living bone and the surface of a load-bearing artificial implant. Osseointegration is very critical in determining the long-term success of dental implants, which is influenced by many factors including mechanics. Mechanical vibration has been shown to be anabolic (promoting osteoblastic bone formation) in enhancing bone modeling process e.g. fractures. Recently, whole body vibration has been shown to increase bone formation around implants in diabetic rats (1). Although proposed as an idea (2), so far there is no data showing the enhancement of osseointegration of dental implants by mechanical vibration. Therefore, it is logical to study the effects of mechanical vibration on the osteogenic potential of the osteoblasts cultured on the dental implant material surface. Our hypothesis is that mechanical vibration enhances proliferation and differentiation of osteoblasts cultured on dental implant material surface. If our hypothesis is proved, mechanical vibration can potentially be applied clinically to enhance osseointegration of dental implants, which will eventually promote the success and longevity of dental implants for patients.

Significance: Without knowing whether mechanical vibration promotes proliferation and differentiation of osteoblasts cultured on dental material surface, it is impossible to provide scientific evidence based on which mechanical vibration can potentially be applied to promote the success and longevity of dental implants. In this study, MC3T3-E1 pre-osteoblasts will be seeded at a density of 4×10^5 /well on the discs of dental implant material (to be provided by Straumann Inc.) in 12-well cell culture dishes. The cells will be subjected to mechanical vibration (0.3g, at 0, 30, 60 and 90 Hz respectively) or kept under static culture condition without vibration as control. The cells will be vibrated 1 hour a day for consecutive 14 days. Cell proliferation will be assessed on day 0, 3, 5, 7, 14 by using MTT method. While differentiation will be examined by day 14 using van Kossa staining. One-way ANOVA will be used to compare the differences of each parameter between the vibrated and the non-vibrated groups, with Tukey comparison to be used to find out the difference between various frequencies. P value less than 0.05 is considered statistically significant.

Innovation/Forward Thinking: To the best of our knowledge, no studies have been reported on the effect of mechanical vibration on osteoblasts cultured on dental implant material surface. This project aims to explore the effects of mechanical vibration on proliferation and differentiation of osteoblasts cultured on dental implant material surface, which will provide scientific evidence for us to potentially use mechanical vibration to enhance osseointegration in dental patients.

Student Involvement: Joseph Curry DDS, Melanie Hammerbeck DDS (1st year orthodontic residents) will participate in this project. They will be involved in designing and implementing experiments, analyzing data and writing research paper.

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Keywords: Osteointegration, Mechanical Vibration, Cell Culture, Osteoblast

Project Title: The Impact of Mechanical Vibration on Human Chondrocytes Under Loading

Faculty Name: Dawei Liu, Associate Professor, School of Dentistry - Orthodontics

Student Name: Theresa Karras, Jamie Martin

Introduction: Temporomandibular joint (TMJ) is the only and highly mobile joint in the craniofacial region, which plays an important role in all dental specialties including orthodontics. The relationship between TMJ disorders (TMJD) and dentofacial orthopedic treatment with direct loading on TMJ is of controversy (1). Clinically the diagnosis, management and prognosis of TMJD in orthodontic patients is case by case. Following "do-no-harm" guideline, all new orthodontic techniques especially those potentially exerting load on TMJ should be carefully assessed. Recently, a new orthodontic device called AcceleDent ("AD" by OrthoAccel Inc.) is commercially available to help accelerate orthodontic tooth movement and alleviate orthodontically associated pain, however its potential effect on TMJ is unknown. A previous study showed the effects of high magnitude (>1g) and high frequencies (>200Hz) of vibration on articular chondrocytes (2), which however does not relate to the spectrum of vibration used in orthodontics and not mimic the situation when orthopedic force is loaded on chondrocytes in orthodontics. A recent laser Doppler study showed that the vibration generated from AD device is transmitted to various anatomical locations of craniofacial region including TMJ (3). Now the question is: does mechanical vibration with a spectrum used in orthodontics influence the biological responses of chondrocytes to orthopedic loading? If yes, positively or negatively? To answer this question, we will study the effects of mechanical vibration on the mechanically loaded chondrocytes in vitro. The aim of our study is to investigate the effect of mechanical vibration (0.3g, at 0, 30, 60 and 90 Hz respectively) on the biological responses (proliferation, differentiation and signaling pathways) of human chondrocytes to orthopedic loading.

Significance: The effects of mechanical vibration (<1g and <100Hz) on the biological responses of chondrocytes to mechanical loading is unknown. Clearly, lack of this knowledge will prevent us from recognizing the potential damage dental vibration can do to the TMJ and finding a way to prevent it. Therefore, the effects of vibration on chondrocytes under mechanical loading will be studied as follows. Human chondrocytes (a gift from Dr. Mary Goldring) will be seeded at a density of 4×10^5 /well in 6-well plates. From day 1, the cells will be subjected to a static mechanical loading (a stretching of 10% cell surface area), with or without mechanical vibration (0.3g, with 0, 30, 60 and 90 Hz respectively) 1 hour/day for 14 consecutive days, with the cells only under static load as control. Proliferation of the chondrocytes will be examined on day 0, 3, 5, 7 and 14 by using MTT method. While the differentiation of the chondrocytes will be assessed on day 14 by staining alcian blue, alkaline phosphatase and collagen II – all three markers for chondrocyte differentiation. To study the signaling pathways involved, the chondrocytes under loading will be subjected to mechanical vibration for only 1 hour. Gene expressions of SOX9, Wnt5a and Runx2 will be examined by real-time PCR while their protein productions evaluated by Western Blot. One-way ANOVA will be used to test the difference of each parameter between vibrated and non-vibrated groups, with Tukey comparison to be used to find the difference between various frequencies ($P < 0.05$ is considered statistically significant).

Innovation/Forward Thinking: So far there is no evidence of the effects of low magnitude high frequency vibration (as generated by the AD device) on the cultured chondrocytes in vitro. Our study will add know knowledge and provide evidence of the impact of vibration on chondrocytes, enabling us to recognize and prevent any possible damage vibration can do to the temporomandibular joint.

Student Involvement: Theresa Karras DDS, Jamie Martin DDS (1st year orthodontic residents) will participate in designing and implementing experiments, analyzing data and writing research papers.

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Keywords: Chondrocyte, Mechanical Vibration, Degeneration, Molecular

Project Title: Application of High Frequency Mechanical Vibration to Regenerate Bone in Experimental Periodontitis

Faculty Name: Dawei Liu, Associate Professor, School of Dentistry - Orthodontics

Student Name: Andrei Taut

Introduction: In the United States one out of every two adults age 30 or older – 64.7 million American adults - has periodontal disease. In adults 65 and older, the prevalence increases to 70.1 percent (Eke PI, et al). Periodontal disease is a chronic inflammatory disease which affects gum tissue and alveolar tooth-supporting bone, which if left untreated, can lead to tooth loss (American Academy of Periodontics) and have an adverse impact on clinical dentistry, including the stability of removable prostheses and success of dental implants (Alikhani, M. et al, 2012). Periodontitis also exerts an adverse impact on systemic health, and has been associated with other chronic inflammatory diseases such as diabetes and cardiovascular disease. Many surgical techniques used in treating bone loss in periodontitis, such as implantation of various types of bone graft and/or bone substitutes, among others, have been shown to be effective for treatment of alveolar bone loss, but are also expensive, invasive and associated with significant morbidity, especially in older adults. Studies have shown that high frequency mechanical vibration has anabolic effects on bone mass and architecture. For example, Honda et al (2001) demonstrated the positive anabolic effects of exercise and loading on weight-bearing bones. However, no knowledge is available on the effects of mechanical vibration on the regeneration of alveolar bone in periodontitis. Therefore, in this project we are going to establish a mouse periodontitis model and investigate whether mechanical vibration helps regenerate alveolar bone in experimental periodontitis.

Significance: Tooth loss is a significant consequence of periodontal disease/alveolar bone loss that can significantly reduce Oral Health-Related Quality of Life (OHRQoL) in affected patients (Gerritsen, AE. et al. 2010). Some studies have demonstrated that having 9 or less teeth reduces the physical index of quality of life to the same extent as cancer or renal disease (Mack, F. et al, 2005). The combination of surgical and pharmaceutical treatments for the regeneration of alveolar bone have been suggested, but are often invasive, costly, and have application limited to small regions of bone loss. Thus, a significant demand exists for an effective, non-invasive, and safe treatment for alveolar bone loss in order to address this emerging public health concern and help to maintain the overall health and well-being of an aging population.

Innovation/Forward Thinking: To the best of our knowledge, we are the first to study the effect of mechanical vibration on alveolar bone regeneration in an experimental periodontitis model. This project aims to uncover the effects of mechanical vibration on bone formation and potentially provide us an opportunity to apply mechanical vibration to help regenerate alveolar bone in patients affected by periodontitis.

Student Involvement: Andrei Taut, an orthodontic resident at Marquette University School of Dentistry will fully participate in this project. He will completely be involved in designing and implementing experiments, analyzing data and writing research paper.

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Keywords: Mechanical Vibration, Periodontal Disease, Animal, Regeneration

Project Title: Chemogenetic and photometric approach for isolating the contribution of brain pathways to drug addiction

Faculty Name: John Mantsch, Professor/Chair, Biomedical Sciences

Student Name: Michael Nordness

Introduction: A significant barrier to treating drug addiction is the lack of an effective treatment for relapse. In the clinical setting, it has been shown that stress is a significant trigger for relapse. This stress-induced relapse can be modeled in a laboratory setting using the self-administration paradigm, during which rats self-administer drugs such as cocaine and are tested for reinstatement of extinguished drug seeking. Previous research has implicated the mesocortical pathway, which is a dopaminergic pathway from the ventral tegmental area (VTA) to the prefrontal cortex (PFC), as highly responsive to stress and as a regulator of motivated behavior. Thus, this pathway is a logical target to evaluate the role of stress in relapse (Mantsch et al., 2015). To evaluate this pathway, we selectively and temporarily inhibited mesocortical neurons to attenuate stress-induced relapse using a novel, dual viral Designer Receptors Exclusively Activated by Designer Drugs (DREADD) approach (Mahler et al., 2014). Although this approach enables pathway specificity, it fails to provide specificity for the diverse phenotypes of neurons. Thus, in order to enhance the specificity of this approach, we will incorporate a novel technique using DREADDs in conjunction with transgenic TH-Cre rodents to enable specific and temporary inhibition of dopamine neurons specifically within the VTA. Furthermore, in order to validate this technique and observe neuronal activity during relapse, we will use a cutting-edge fiber photometry technique based on intracellular calcium levels to enable in-vivo, real-time measurement of specific neuronal populations with both pathway-type and neuron-type specificity (Kim et al., 2016). Using these cutting-edge approaches will allow for neuronal phenotype-specific and pathway-specific manipulations, which would prove effective in understanding the physiological basis of stress-induced relapse.

Significance: Drug addiction, a brain disease resulting in the disruption of normal brain physiology, poses the significant societal burden of over \$700 billion annually, with costs ranging from crime to lost productivity (NIDA, 2011). In addition to its staggering financial costs, drug addiction has been shown to have a high level of comorbidity with other mental illnesses—for example, anxiety disorders and post-traumatic stress disorder. One difficulty in addressing drug addiction is stress, which has been shown to increase the likelihood of relapse to drug use (Mantsch et al., 2015). Thus, gaining a greater understanding of this relationship between stress and relapse is critical for the development of more effective treatments and for ultimately addressing the societal burden of drug addiction.

Innovation/Forward Thinking: Integrating both the transgenic rodent and DREADD techniques proves innovative in that both specific neuron phenotypes and pathways can be inhibited or activated by administering an otherwise inert drug, Clozapine N-Oxide. This novel approach enables the identification of the role of the mesocortical pathway at a level of specificity that has not yet been achieved. In addition, by integrating the cutting-edge fiber photometry, we will gain the ability to understand the activity of specific neuronal populations in real time and in vivo. Thus, integrating these three cutting-edge approaches in a novel manner has the potential to uncover specific therapeutic targets, and, furthermore, provides a basis for future development of a pharmaceutical to prevent stress-induced drug seeking.

Student Involvement: The undergraduate student Michael Nordness has assisted with the immunohistochemistry and with the surgical viral delivery for the DREADD approach. He will have a leading continued role in this project, which will include performing surgical procedures, and processing and analyzing post-mortem brain tissue.

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Keywords: addiction, relapse, stress, neuroscience

Project Title: Stress distribution on endodontically treated maxillary premolars with minimum remaining tooth structure when restored with custom post/core materials: A three-dimensional finite element analysis model.

Faculty Name: Georgios Maroulakos, Assistant Professor, Prosthodontics
Arndt Guentsch, Associate Professor; Chair, Surgical Sciences, Periodontics

Student Name: Michael Smoljan

Introduction: The restoration of the root canal treated tooth is one of the most challenging aspects of restorative dentistry. If there is substantial loss of tooth structure, a post may be necessary to retain the tooth's core that will restore the lost tooth structure.

Many different post and core systems are available and differ depending on the type of the post (prefabricated, cast metal,) design (tapered, parallel sided, threaded,) surface texture (serrated, smooth,) and material (metallic, fiber reinforced, ceramic.) Custom cast post and cores have the advantage of having the post and the core connected as one piece. As a result, they are more reliable as there is no possibility of delamination between the post and the core unless there is a fracture between the core and the post (Plasmans, 1986). Additionally, they are superior to prefabricated posts of any kind, as they can fit a root canal more intimately, and their morphological shape and structure provides resistance to torsional stresses (Morgano, 1993).

Finite element analysis (FEA) is an alternative method of evaluating stress and strain distribution on dentin and restorations of teeth restored with post and cores using different types of post systems and post lengths and at various levels of remaining tooth structure (Spazzin, 2009). A three-dimensional FEA model comparing custom ceramic with conventional custom cast post/cores has not been previously developed. This study will compare the stress distribution of maxillary premolars restored with a custom post and core made of gold, zirconia, or ceramic cemented with one of two different resin cements.

Significance: A restored endodontically treated tooth is a highly complex system due to the number of different materials used in the restorative process. In the absence of clinical studies that could compare different treatment modalities in a standardized way, a 3D FEA model should provide important information that can assist with material selection in these challenging situations.

Innovation/Forward Thinking: The results of this study have the potential to influence treatment outcomes when a dentist is tasked with restoring an endodontically treated tooth. As technology continues to change and advance within dentistry, there are more ways to create custom restorative options for patients. This study will provide dentists with data regarding which custom post and core option coupled with a given resin cement will provide the most favorable outcome for the restoration of a maxillary premolar. Furthermore, this study continues to validate the use of FEA in dentistry.

Student Involvement: Michael Smoljan is serving as student researcher under the guidance of Dr. Maroulakos and Dr. Guentsch. He will be continuing his dental education in the Endodontic Residency program at Marquette in the summer of 2018. He is excited to broaden his scope of research experience with this project.

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Keywords: Finite Element Analysis, Custom Post and Core, Restoration, Endodontically Treated Teeth

Project Title: The inactivation of Elizabethkingia anopheles through Chlorination.

Faculty Name: Brooke Mayer, Assistant Professor, Civil, Construction, and Environmental Engineering

Student Name: Djadde Denson

Introduction: Microscopic with effects largely undetectable without lab confirmation, and potentially fatal to immune compromised people. On January 15th 2015 the first reported case of Elizabethkingia anopheles was reported in the state of Wisconsin, according to the Wisconsin Department of Health services (DHS). Since the first reported cases in 2015 until May 2016, there has been a total of 67 confirmed cases along with 19 deaths in Wisconsin and reports of this bloodstream infection in patients in Michigan. The original source of this infection is unknown, according to the CDC, and majority of the effected are over the age of 65. Amongst the patients who are affected with Elizabethkingia, the mortality rate is high due to lack of treatment options. Also, detection is difficult because the symptoms resemble that of a cold and assuaging an outbreak is a significant issue since traditional methods of inactivation are sometimes not applicable because of its gram-negative nature. The purpose of our experiment is to respond to a rapid response grant signified by the National Science Foundation (NSF) to test effects of chlorination on Elizabethkingia in water. The experiments explored the variables of time in chlorinated solution, temperature of treatment, and concentration of chlorine.

Significance: Elizabethkingia anopheles is commonly found in nature and alone causes no major health concerns in humans (DHS). However, in tandem with an immune compromised individual, it acts as a catalyst to the current medical condition. Under the right condition Elizabethkingia can thrive and multiply very rapidly and its gram-negative behavior can be tricky to inactivate completely. Experimenting with different methods of disinfection increases our chances of achieving a log 3 inactivation, which is standard for bacteria inactivation.

Innovation/Forward Thinking: The overall goal of our experimentation with Elizabethkingia is a call to action to the rapid response grant called forth by the NSF. Initially there were four proposed methods of inactivation: chlorination, mono-chlorination, ultraviolet irradiation, and ozonation. All have their benefits and setbacks, however thorough testing of each method is required to gather the data needed to put these processes into practical use. To help the people affected by Elizabethkingia anopheles is what we set out to do, these methods provide the best chances to achieve log 3 inactivation.

Student Involvement: Research, procedure, data analysis

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Keywords: Elizabethkingia, Gram-negative, Log inactivation

Project Title: Stochastic Search methods for Mobile Manipulator Calibration

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Student Name: Samuel Amoako-Frimpong, Matthew Messina

Introduction: Robotic manipulators have a wide variety of applications, most prominently in manufacturing. With their increased deployment, the need for flexibility to enable reassignment with minimal reconfiguration, and motion in unstructured environments is high - especially in small industries (Christensen et al., 2016). Mobile manipulators have the potential to address these needs, but the simultaneous motion of the manipulator and mobile platform reduces their precision (Hamner, Koterba, Shi, Simmons, & Singh, 2009). Previous attempts at solving this problem have used deterministic approaches (Bostelman, Hong & Marvel, 2015) such as a spiral search around the expected location of the end-effector with the platform stationary. We propose the use of stochastic methods to improve search performance in locating a group of retroreflective markers.

Significance: Due to their ability of rapid retasking, flexible robotic manufacturing systems have the potential to significantly increase the U.S. manufacturing competitiveness. Flexibility is particularly important for small and medium enterprises, which do not have the production scale to justify investing heavily in task-specific robotic systems (Messina, Cheok, Franaszek & Van Wyk, 2017). Mobile robotic manipulators are one important component in the development of the flexible manufacturing systems of the future, but dynamic manipulation is a notoriously challenging task (Hamner et al., 2009). Hence, the ability to quickly and accurately localize the mobile manipulator with respect to an object of interest in the presence of uncertainty is of relevance not only for the purpose of robot calibration and accuracy evaluation but also for the development of robust and efficient sensor-based flexible robotic systems.

Innovation/Forward Thinking: Our focus on enabling error compensation and performance evaluation in mobile manipulators in scenarios with both the base and arm in motion, is novel. Our use of Bayesian methods to enable performance gains in the scenario stated, is also unique. Our work sets the stage to enable the application of mobile manipulators to a wide array of tasks for which they are currently suited, but not widely used –for example, in the painting or assembly of large structures like aircraft and wind turbines.

Student Involvement: This project is under the guidance of Dr. Henry Medeiros - with Amoako-Frimpong Samuel undertaking the research, assisted by Matthew Messina. The authors would like to acknowledge the assistance of Jeremy Marvel and Roger Bostelman in the execution of this project.

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Project Title: Multi-species flower detection using transferable deep learning features and multi-target tracking algorithms

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Student Name: Philipe Ambrozio Dias

Introduction: Several automated computer vision systems have been proposed to estimate bloom intensity, i.e., the number of flowers present in an orchard. However, existing methods are mostly species-specific and present overall performance still far from satisfactory even in relatively controlled environments (e.g., at night with artificial illumination) (Gongal et al., 2016).

Significance: Together with factors such as climate, bloom intensity is especially important to guide the removal of some flowers and fruitlets in the early growing season, which directly affects fruit size, coloration, taste, and firmness. Despite their importance, these activities are currently still carried out manually with the assistance of rudimentary tools.

Innovation/Forward Thinking: Inspired by successful works in multiple computer vision tasks, we have been working on a novel method for flower detection where a pre-trained convolutional neural network (CNN) is fine-tuned to become particularly sensitive to flowers. Our current approach significantly outperforms the state-of-the-art in terms of recall, precision and also generalization capability, as revealed by an assessment on images acquired from different flower species and under different conditions. We aim at further extending its applicability to detect other flower species and fruitlets, by means of transfer learning approaches (Yosinski, Clune, Bengio, & Lipson, 2014) such as data augmentation and the use of external datasets. Additionally, we intend to explore probabilistic approaches that estimate motion between frames (e.g. particle filtering) to locate and measure the trajectory of flowers (Mozhdehi & Medeiros, 2017).

Student Involvement: Dr. Henry Medeiros directs the research project. Philipe Dias works on implementation and evaluation of deep learning and tracking algorithms for bloom intensity estimation.

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Keywords: Bloom Intensity Estimation, Deep Learning, Object Detection, Multi-target Tracking

Project Title: Multi-Model Deep Convolutional Iterative Particle Filter for Visual Tracking

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Student Name: Reza Jalil Mozhdehi

Introduction: Visual Tracking has been a challenging computer vision problem, particularly in situations involving target occlusion, deformation, or in-plane and out-of-plane rotations. Recently, deep convolutional neural networks (CNN) have been widely employed in visual tracking because of their outstanding object recognition capability [1]. We employ the features generated by a CNN in conjunction with a Monte Carlo filtering mechanism to improve tracking.

Significance: Visual tracking is one of most fundamental research areas of computer vision. Applications include many fields such as robotics, surveillance, autonomous driving, automation, medicine, and unmanned aerial vehicles.

Innovation/Forward Thinking: In this project, we propose a novel tracker based on integrating a CNN with particle and correlation filters. The features are extracted from the CNN and the target's position is estimated by the correlation filter [2]. A novel contribution of our tracker is to use several models for each frame rather than one model, which is typically used in correlation filters [3]. The particle filter is used to increase the accuracy of the estimated positions as well as the size of the target. The iterative the particle filter helps particles to correct themselves so that the most relevant particles are reused. We use different strategies to assess the remaining particles. Our tracker defines a confidence score for each correlation response map based on its entropy. According to these confidence scores, three different states are considered: target-found, partially-lost and fully-lost. Different strategies are applied to update the models: using a short memory to save some previous models and saving the model of last target-found state for partially-lost state and not updating the models for the fully-lost state. We test our tracker on the OTB100 benchmark dataset (REF), which includes 100 challenging data sequences and 13 challenging scenarios [4]. The initial results show that our tracker performs favorably against state-of-the-art methods. In the next step, we plan to change our CNN with a more recent network, which likely will extract more accurate features. By incorporating recent state-of-the-art multi-task algorithms [5], which define several tasks and assign a particular data sequences to each task, we hope to improve our performance as well.

Student Involvement: Dr. Henry Medeiros directs the research project. Reza Jalil Mozhdehi works on implementation and evaluation of the tracker.

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Keywords: Deep Convolutional Neural Network, Particle Filter, Correlation Response Map, Visual Tracking

Project Title: Improving Bayesian Sensor Fusion with Hierarchical Autoencoders

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Student Name: Yevgeniy Reznichenko

Introduction: Within the computer vision and robotics communities, there has been significantly growing interest in robotic platforms for object or pedestrian tracking. The design of such platforms usually involves several elements: trackers that are flexible enough to detect and follow different types of targets in different scenarios according to Martinez (2013) a robust depth estimation mechanism; and, well tuned motion controls[4]. Sensor fusion is an approach that takes information from multiple trackers and "combines" them to form an estimate that is often better than any individual tracker working alone. Recent research in this field shows that neural networks are especially successful in learning to model complex behavior. By appropriately weighing properly functioning trackers and anomalous trackers, we can appropriately weigh the results in the ensemble. Denoising autoencoders (Wang, 2016) and variational autoencoders (Suh, 2016) have shown the ability to find abstractions governing normal behavior. By feeding the network examples of successful tracking, the statistical properties learned by the neural network can be used to penalize abnormal behavior. Once an abnormal event is detected, the tracker can be weighed accordingly to improve fusion. We train with tracking data from our tracker ensemble on the OTB-100 benchmark(Wu, 2013) and evaluate success by looking at how accurately we can detect outliers.

Significance: The present work could change the way people use small following UAVs (Unmanned Aerial Vehicles). This project aims to improve the technology that is in place for UAVs to become fully capable of autonomously tracking objects. This technology would be useful in industries such as film-making and surveillance. So far, there is no UAV capable of following an object robustly enough using computer vision techniques.

Innovation/Forward Thinking: The proposed data fusion is a novel method for addressing a fundamental issue in target tracking. Future improvements would involve using a recurrent architecture, dilated convolutions or generative adversarial learning to further improve our models.

Student Involvement: This is a research project under the guidance of Dr. Henry Medeiros and developed by the student Yevgeniy V. Reznichenko, who is researching the different methods available today in the computer vision community. These methods will be tested and evaluated in a DJI Matrice 100.

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Keywords: Bayesian, Hierarchical Autoencoder, UAV, Image Tracking

Project Title: Tracking Passengers and Divested Items at Airport Checkpoints

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Student Name: Abubakar Siddique, Benjamin Mol

Introduction: Automated video surveillance is defined as detection, tracking and reconstruction of the objects in a scene. This enables more complex analysis like monitoring patterns of normal and abnormal behavior. Accurate and precise surveillance in crowded scenes is one of the biggest challenges in computer vision applications. Previous research has used mixture of Gaussian method for detection and separate tracker used for both passengers and baggage (Wu, et.al., 2011). The research goal of this project is to use state-of-the-art deep learning algorithms to detect and track the passengers and their divested items at airport security checkpoints. To maintain the association between passengers and the divested items, CNN-based deep learning algorithms are used to extract the appearance and motion features (Redmon, et.al., 2016), (Liu, et.al., 2016) and promising results are obtained using multiple hypothesis tracking (Kim, et.al., 2015). However, we still must address challenges such as keeping the individual identification number for each person and their divested items across cameras. Typically, camera calibration information is used to stitch multiple camera videos, our method will utilize multiple cameras to discard partial or redundant detections and maintain consistent tracking.

Significance: The results of this research project will be used to create a tool for the Department of Homeland Security to enhance safety not only at airport checkpoints, but also on crowded scenes such as rail stations, bus stations, and shopping malls. This project is also useful for identifying abnormal activities by using data association in the crowded scenes. For example, any divested items left behind can be identified.

Innovation/Forward Thinking: Detecting people and their divested items using deep learning algorithms and refining these detections by using data fusion from several state-of-the-art models is novel in computer vision research. In addition, the fusion of detection results from different models can augment consistency in tracking for multiple cameras. So, this approach of refining and combining multiple deep neural networks will create the pathways for getting consistent tracking in camera networks. As the same object is detected by multiple cameras, the goal is to use geometric constraints of the multi-camera projection to discard partial detections.

Student Involvement: This research project is under the guidance of Dr. Henry Medeiros and conducted by the student Abubakar Siddique, who is researching the different state-of-the-art methods in computer vision. These methods are primarily used on an airport checkpoint dataset which is recorded by the Kostas Research Institute (KRI) lab at Northeastern University using thirteen overhead cameras.

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Keywords: Convolutional Neural Network, Appearance Model, Multiple Hypothesis Tracking, Data Fusion, Multiple Camera Network, Camera Projection, Stitching

Project Title: Quantification of Dispersal Patterns of Invasive Insects with Unmanned Aerial Systems

Faculty Name: Henry Medeiros, Assistant Professor, Electrical and Computer Engineering

Miguel Hernandez Virto, Research Associate, Electrical and Computer Engineering

Student Name: Brian Stumph, Weihua Liu

Introduction: Invasive species are often inadvertently transported from their native range to novel habitats where they often have strongly negative impacts on food security, public health, economic interests, and native species biodiversity. As an example, in the United States, annual economic losses from invasive species are estimated at \$120 billion (Pimentel et al., 2005), and these severe impacts are predicted to continue (Paini et al., 2016). A key element to the mitigation of invasive pest damage to both natural environments as well as agricultural production is understanding their migration patterns.

In this project, we propose to study the dispersal patterns of invasive insect species employing a small unmanned aerial system (sUAS). This system, equipped with recently developed novel laser imaging technology, can collect on-field high-resolution data to be later processed in a computer vision algorithm pipeline, generating accurate geotagged detections that can be easily studied over a scaled map.

Significance: Although there are studies about insect dispersal, they are limited to mark-release-recapture techniques with a human in the loop, which have significant drawbacks. Recapture is a very laborious, time-consuming, and error-prone task. In addition, due to the labor-intensive nature of the process, very few samples of the insect motion can be captured, typically < 5% (Merckx et al., 2009), which negatively impacts the accuracy of the resulting dispersal models. Preliminary results show that, with our present method, we are able to detect 60% of the insects used in outdoor tests (Virto et al., 2017), drastically improving the counting accuracy of the current manual methods, and being much more time efficient.

Innovation/Forward Thinking: To the best of our knowledge, this is the first automated insect detection system in the literature. The future work on the sUAS design and sensing equipment, as well as in the video processing algorithm, will allow us to create a fully automated system which is easy to implement and can be used for a wide range of mark-and-release applications.

Student Involvement: This project started in early 2017, as a partnership between the United States Agricultural Department and Computer Vision and Robotics Lab (MU), involving Dr. Medeiros as faculty and Miguel Hernandez as Master student. After several months of research and the incorporation of two new undergraduate we obtained promising results and we were able to publish a paper for the International Conference on Robotics and Automation. Now, we are all working as a consolidated team to reach the ultimate goal of the project and see its application in real world.

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Keywords: Computer Vision, Robotics, Aerial System, Agriculture

Project Title: The Perception of Teachers in an Urban Public School District of their Ability to Assess and Intervene for Student Mental Health Issues

Faculty Name: Jennifer Ohlendorf, Assistant Professor, Nursing

Student Name: Jeffrey Kopaniasz

Introduction: Mental health disorders are on the rise in children; currently, 1 in 5 school-aged children have been diagnosed with at least 1 mental health condition. There is evidence that many more children go undiagnosed or under-treated. Because children spend a significant amount of time in the school environment, professional educators may be in an ideal position to identify children's mental health needs. Additionally, teachers and school nurses can work together to develop improved strategies to respond to problematic behaviors displayed by children who have undiagnosed or under-treated mental health disorders.

Significance: Current disciplinary procedures in most urban public schools are not informed by best practices to respond to children with mental health disorders. This is thought to be one contributor to the 'school to prison pipeline' where school staff responses to problematic behaviors leads to a quickly-escalating series of disciplinary procedures culminating in contact with the juvenile justice system. Currently, 70% of youth in the juvenile justice system have one or more mental health disorder.

Innovation/Forward Thinking: The implications of these findings could inform future interdisciplinary work between public health nurses, school nurses, and educators to respond more effectively to youth with a mental health disorder, breaking the cycle leading to escalating disciplinary procedures.

Student Involvement: Jeff has designed this project from conception through development of methods and implementation. He will begin data collection/interviews during Winter Break.

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Keywords: Mental Health, Education, Adolescents

Project Title: MPI-GIS: An MPI System for Big Spatial Data

Faculty Name: Satish Puri, Assistant Professor, Mathematics, Statistics, and Computer Science

Student Name: Anmol Paudel

Introduction: In recent times, geospatial datasets are growing in terms of size, complexity and heterogeneity. High performance systems are needed to analyze such data to produce actionable insights in an efficient manner. For polygonal (a.k.a vector) datasets, operations such as Read/Write, data partitioning, and communication becomes challenging in a cluster environment. Our work MPI-GIS is equipped with MPI-Vector-IO, a parallel Read/Write library that has been designed using MPI-IO specifically for irregular vector data formats such as WKT, CSV, etc. MPI-GIS is based on GEOS open source library which makes MPI aware of spatial data and spatial primitives and provides support for spatial data types embedded within collective computation and communication using MPI message-passing library. The poster shows the research that is being done to test load-balancing in a parallel Read/Write context of geospatial datasets using MPI-GIS.

Significance: A parallel Read/Write library and a software for geospatial computations on supercomputing systems will impact many geoscience applications.

Innovation/Forward Thinking: Read/Write operations on files containing polygonal spatial data are currently a bottleneck in supercomputing systems and there is no software library available. Our system aims to fulfill this gap. It will leverage the fast parallel file system and communication network to yield real time results.

Keywords: Spatial Datasets, MPI-IO, Load-balancing, Parallel Read/Write

Project Title: Regional Eigenvalue Assignment

Faculty Name: Susan Schneider, Associate Professor, Electrical and Computer Engineering

Student Name: Wenyan Min

Introduction: In previous study, we have successfully developed the design procedure for a state feedback controller which assigns the closed loop system eigenvalues inside a regional circle with center and radius specified by the designer. In this study, we focus on how weighting matrices Q and R ratio (Control input and state) affects the location of the eigenvalue.

Significance: The Chang-letov analysis provides a board view of how exactly weighting matrices Q and R affect the location of eigenvalues of the closed loop system. With detailed understanding of the trajectory of the eigenvalues, the designer has more flexibility while deciding between the control input and state, which is the Q and R in this study.

Innovation/Forward Thinking: We have been able to cast the regional eigenvalues placement feedback control design problem for linear systems into the form of the discrete algebraic Riccati equation allowing designers to repurpose existing numerical algorithms. With Chang-Letov study, the designer can further refine the time domain response by adjusting the ratio between control input Q and state R . While this innovative design provides a degree of robustness for the design process, we wish to develop expressions for the upper and lower bounds for the solution to further assist designers when choosing the regionalization parameters to better meet robustness requirements.

Student Involvement: All the simulations and the derivations of algebraic equation will be performed under professor's guidance and instruct. Matlab is used to verify and simulate the results of the study.

Project Title: Protection Against Attacks on Cyber Physical Systems Controlled by PLCs
Faculty Name: Susan Schneider, Associate Professor, Electrical and Computer Engineering
Edwin Yaz, Professor, Electrical and Computer Engineering
Jennifer Bonniwell, Assistant Professor, Milwaukee School of Engineering
Student Name: Yuqin Weng

Introduction: One difference between a traditional plant control system and a Cyber Physical System (CPS) is that the plant to be controlled in the CPS is linked to the internet for communication of control actions and/or sensor information. Some simple examples of how a CPS can be compromised or hacked include improperly increasing or decreasing the usage of electricity on a smart grid that leads to overbilling of customers or providing incorrect control signals to water resource management systems that potentially result in flooding [1].

Significance: The purpose of this project is to investigate how to detect cyber threats and prevent dangerous attacks from occurring on Cyber Physical Systems controlled by programmable logic controllers (PLC). PLCs are commonly used to control processes in industries such as the petroleum industry, electric power grids or automotive manufacturing plants [1]. Keeping a CPS controlled by PLC unharmed by hackers is one of the main goals of this project.

Innovation/Forward Thinking: In this project, we will develop a discrete time model of a CPS that will be used to simulate attacks allowing us to evaluate detection and protection methods. With the help of MATLAB and Simulink, we can simulate what might happen when the system is harmed. There are several methods to simulate cyber-attacks on a plant, such as replacing the input signal, or changing the feedback loop or sending some false information to the sensors. By using the "hacked" model, we can easily find differences between the original system and the compromised one. Through this analysis, we will evaluate the robustness of the control system to the attacks. We will also emulate the PLC controller for the CPS in the MATLAB/Simulink environment. By using IEC 61131-3 compliant translation methodology [2] or other method, we may develop PLC programs using ladder logic and convert them into MATLAB to incorporate them into the plant model.

After initial investigations to validate the simulations with a simple system the "Anti-Windup PID Control Demonstration" from MATLAB [3], we intend to simulate attacks on a more complicated system, such as Tennessee-Eastman plant [4] to compare our proposed mitigation methods with others in the literature.

Student Involvement: The student will be doing an extensive literature search, creating models, running simulations, etc. This research will be a significant part of his M.S. thesis.

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Keywords: Cyber Physical System, Programmable Logic Controller, Protection

Project Title: Running With and Without Arm Swing

Faculty Name: Andrew Starsky, Clinical Associate Professor, Physical Therapy

Student Name: Ben Dorow, David Hoffman

Introduction: The purpose of this study was to analyze the effect of normal arm swing versus absence of arm swing on joint kinematics in the lower extremity and perceived exertion during running at a set speed of 7.0 mph.

Significance: We hypothesized that running without arm swing would increase the perceived exertion of the task compared to normal arm swing. We also hypothesized that running without arm swing would create exaggerated joint motion primarily at the pelvis with altered joint kinematics at the hip, knee, and ankle.

Innovation/Forward Thinking: Following the results of this research, in the future we would like to look at the differences in energy expenditure between the two running conditions. In addition to this we would also like to explore how those with upper extremity amputations (elbow disarticulation and above) who wish to continue running are impacted by exploring the arthrokinematics of their lower extremities and the potential role that addition of a prosthetic may play. Another area of interest would be the role arm constraint treadmill training could play in children with cerebral palsy.

Student Involvement: Students would utilize the motion analysis laboratory to acquire this data, would run the experiments, and analyze/present the results.

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Keywords: running, arm swing, kinematics

Project Title: Surface modification of 3D printed implants and scaffold for oral and dental tissue engineering

Faculty Name: Lobat Tayebi, Associate Professor, School of Dentistry - Developmental Sciences

Student Name: Jonathan Wirth, Casey Dentino, Robert Madrigal, Zachary Nicholson

Introduction: Additive manufacturing, also known as 3D-printing, allows for the design and fabrication of products ranging from automotive parts to dental implants and scaffolds. Various materials have been used for the 3D-printing of dental scaffolds, ranging from hydrogels to thermoplastic polymers. However, many of these scaffold materials struggle to replicate ideal biological responses and as a result low cell attachment is often observed. Surface modification of these scaffolds is necessary to address this problem, which is the focus of the proposed research.

Significance: Surface modification of 3D-printed scaffolds using bioactive material maintains the original mechanical properties of the construct while also modifies the surface for better cell attachment and biological response. Various methods have been developed to coat the surface of scaffolds with different combinations of materials. This research aims to develop a new method to coat 3D-printed dental scaffolds. The technique is solvent-free and can make coating layers with excellent bonding strength and uniform deposition. More specifically, polycaprolactone 3D-printed scaffolds will be coated using 1) calcium phosphate, 2) TiO₂ and 3) combination of hydroxyapatite and calcium phosphate. The surface roughness will be analyzed and the quality of coating will be confirmed using scanning electron microscopy and laser microscopy.

Innovation/Forward Thinking: Current surface modification methods suffer from an array of disadvantages, such as low bonding strength, low quality coating, non-uniform coating, use of a solvent, and the incapacity for in-depth coating. In this project, we are developing a novel one-step solvent-free coating method by taking advantage of routine hydrostatic pressures and temperature during preparation of the samples. This novel method is fast, efficient, and applicable to a wide range of polymers and coating materials.

Student Involvement: Four pre-doctoral DDS students (Jonathan Wirth, Robert Madrigal, Zachary Nicholson and Casey Dentino) are involved in this project. Each of these students is responsible for coating of specific materials in 3D-printed scaffolds. The work will be done under supervision of Dr. Tayebi and with the help of professional researchers at the School of Dentistry.

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Keywords: 3D-Printed Scaffolds, Dental Tissue Engineering, Surface Modification, Dental Implants

Project Title: Incorporation of Carbon-Dots Into Endodontics Injectable Gels to Improve the Antibacterial Properties

Faculty Name: Lobat Tayebi, Associate Professor, School of Dentistry - Developmental Sciences

Student Name: Maksim Montatskiy

Introduction: Current irrigation and intra-canal medications used in endodontics do not provide adequate and complete bacterial eradication during endodontic treatments. The most common irrigation solution used for disinfection during an endodontic appointment is 5.25% sodium hypochlorite, while the most common inter-appointment medication is calcium hydroxide. Bacteria involved in long-standing endodontic infections are organized as a biofilm that tightly adheres to dentinal walls. Often times the bacteria found within biofilm can be resistant to these irrigation and medicament protocols. This can lead to persistently infected canal spaces, which correlate to poor healing outcomes. Additionally, evidence shows that both sodium hypochlorite and calcium hydroxide are cytotoxic to human dental pulpal stem cells. A new material and method for disinfection is desirable.

Significance: Various drugs and medicaments are being developed for removal of microbial biofilm with the usage of scaffolds and carrier systems. Literature advocates the great potential for both carbon dots and hydrogels in biomedical applications. With varying compositions and drug release strategies, an ideal injectable formulation for use within the endodontic canal space has yet to be thoroughly evaluated. With such a new formulation, it is necessary to determine cytotoxicity to establish an effective, yet safe therapeutic concentration.

Innovation/Forward Thinking: While studied in other fields of medicine, the use of carbon dots incorporated into hydrogel scaffolds has not been investigated in endodontic context. Present study utilizes a simple, inexpensive approach to fabricate such gels and study its cytotoxic potential on human dental pulpal stem cells.

Student Involvement: This project has been started a few months ago and is planned to be completed within the next 9-12 months. Two graduate students in endodontics (Housley and Montatskiy) are working on this project with the help of professional researchers (Rasoulianboroujeni, Yadegari, Khoshroo and Nikita Tongas) and under supervision of a team of faculty in the School of Dentistry with complementary expertise of clinical endodontics and biomaterials (Stover, Ibrahim and Tayebi).

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Keywords: Endodontics, Hydrogel, Carbon dot, Cytotoxicity

Project Title: An In Vitro Analysis of Rake Angle in K3 Files by Laser Probe Measuring

Faculty Name: Jeffrey Toth, Adjunct Professor, Biomedical Engineering

Sheila Stover, Clinical Professor, School of Dentistry - Endodontics

Student Name: Michael Smoljan

Introduction: According to the American Dental Association, more than 20 million root canals are performed in the United States every year (American Dental Association, 2007). General dentists and endodontists use files to mechanically clean and shape the root canals within teeth. Endodontic files possess a rake angle, which is the angle formed by the cutting edge and the radius of the file. Endodontic files with positive rake angles cut tooth structure whereas files with negative angles scrape tooth structure, suggesting that positive rake angle files possess better cutting efficiency (Hargreaves, 2011). Kerr manufactures and markets their K3 file as a positive rake angle file (Kerr Dental, 2017). While studies have been completed to evaluate the cutting efficiency of different files systems, there is limited research validating the claims of Kerr that their files truly possess positive rake angles. One study directly measured the K3 file by mounting, sectioning, and microscope analysis of the file which concluded that the K3 file had negative rake angles (Chow, 2005). Another limitation is that the Chow study used destructive analysis. We propose to use utilize non-destructive analysis the assess the files rake angles. The aim of this study is to investigate the rake angles of the K3 file digitally through non-contact measurement systems.

Significance: Understanding the physical and mechanical properties of instruments provides clinicians with more information to improve the success of their treatment. Previous studies have been based on destructive analysis whereas the current study proposes to use non-destructive MicroCT and laser probe measuring to create a CAD based digital rendering of the file. The rake angle will then be measured digitally, at multiple points along the long axis of the file. Although a published destructive study documented that the K3 file did not have positive rake angles, Kerr continues to market the file as having a positive rake angle. This study will confirm or dispute the positive rake angle claims published by Kerr which has subsequently been referenced in endodontic literature.

Innovation/Forward Thinking: While providing dentists and endodontists with enhanced information is a critical aspect of the study, the scanning and analytic protocols developed for this study will set the precedent for further dental instrument research. This innovative approach to instrument metrology has the potential to be applied to other instruments used in dentistry that have been too small to measure using conventional techniques.

Student Involvement: Michael Smoljan is serving as student researcher under the guidance of Dr. Toth and Dr. Stover. He will be continuing his dental education in the Endodontic Residency program at Marquette in the summer of 2018. Michael hopes to continue working with Dr. Toth and Dr. Stover to become an expert team in dental metrology.

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Keywords: endodontic file, rake angle, metrology, comparison

Project Title: Application of Kalman Filtering to Improve Response of Radiation Detectors

Faculty Name: Edwin Yaz, Professor, Electrical and Computer Engineering

Susan Schneider, Associate Professor, Electrical and Computer Engineering

Student Name: Abdulelah Alshareef

Introduction: The Kalman filter is a set of mathematical equations which estimates the state of a process. Furthermore, the most important characteristic of Kalman filter is that minimizes the mean square estimation error. In this project, we shall use Kalman filter with a radiation detector to estimate the type of isotope, which decays gamma radiation. There are many kinds of radiation detectors and each of them has different characteristics and applications. In our work, we shall use scintillation detectors with NaI (Sodium Iodide) for several reasons, for instance, NaI has a very high luminescence efficiency since and it produces 38 photons per keV. In brief, we shall design a Kalman filter to estimate the type of isotope which decays gamma radiation.

Significance: Designing a Kalman filter to estimate the type of isotope is very vital because that help us to know what the isotope is from its radiation.

Innovation/Forward Thinking: The method that we shall use is to model Kalman filter to detect an isotope in an ideal situation. The ideal situation is an isotope does not interact with its environment. In this project, we shall model a bank of Kalman filters for three isotopes which are Cesium (Cs 137), Cobalt (Co 60), and Sodium (Na 22) to estimate what the source of radiation is. After that, a bank of Kalman filters will be set up to estimate the kind of isotope from its radiation.

Student Involvement: The student will be setting up a bank of Kalman filters to be used in conjunction with data obtained from a scintillation detector.

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Keywords: Kalman filter, Filter banks, Scintillation Detectors

Project Title: The Effect of Delays in Deadbeat-Controlled Systems

Faculty Name: Edwin Yaz, Professor, Electrical and Computer Engineering

Susan Schneider, Associate Professor, Electrical and Computer Engineering

Jennifer Bonniwell, Assistant Professor, Milwaukee School of Engineering

Student Name: Saud Binhumud

Introduction: One of the most important performance characteristics of control systems is the stability of the closed-loop system. For discrete time linear time invariant systems, the most stable control method is called deadbeat-control. The goal of deadbeat control is to place all the eigenvalues of the closed-loop system at the origin of the unit circle by state feedback so that the system has the largest possible stability margin. For example, the state space equation of a first order discrete time system is $x_{k+1} = ax_k + u_k$, where x_k is the state variable, and u_k is the control at time instant k . The deadbeat control is $u_k = -ax_k$ so that the closed loop system has its eigenvalues at 0. However, due to sensor or communication delays, the implemented control may be $u_k = -ax_{k-i}$, where i is the number of delays.

Significance: As mentioned in the introduction, the stability of the system is very important. In order to make sure that the closed-loop system is stable, we need to analyze stability in the presence of delays. This will determine the stability robustness of the controlled system with delays.

Innovation/Forward Thinking: This research will discuss the effect of delays on the stability of deadbeat-controlled systems. First, we will examine the behavior of a first order system for one, two, up to n^{th} steps of delay. Furthermore, we will continue our work at higher order systems by comparing the eigenvalue locations of the system when we have n^{th} step delays through the use of Matlab and applying methods such as Jury stability test.

Student Involvement: The student will work under the guidance of the faculty advisors to run all simulations and analyze the results to find relations between the control gains, the order of the system and the number of delays in order to predict the stability and stability margins for the delayed control systems. Matlab will be used for the system simulations and root locus plots to determine system stability based on closed-loop eigenvalue location. Analytic methods such as the Jury stability test will also be employed.

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Keywords: Deadbeat control, control delays, stability

Project Title: Risk Assessment and Threat Detection for Industrial Control Systems

Faculty Name: Edwin Yaz, Professor, Electrical and Computer Engineering

Susan Schneider, Associate Professor, Electrical and Computer Engineering

Jennifer Bonniwell, Assistant Professor, Milwaukee School of Engineering

Student Name: Jiayi Su

Introduction: The number of attacks targeting process control systems, like logistics control systems at airports and offshore oil platform leak-detection systems [1] continue to increase. These attacks could cause an irreversible loss if successful. An example of such an attack was on the Maroochy Shire Council's sewage control system in Queensland, Australia. A hacker used a laptop and a radio transmitter to take control of 150 sewage pumping stations. Over a three-month period, he released one million liters of untreated sewage into a stormwater drain from where it flowed into local waterways. The attack was motivated by revenge on the part of the hacker after he failed to secure a job with the Maroochy Shire Council [2]. Unfortunately, ways to detect those attacks are still limited because attack signals are always hidden, and sometimes hackers enter through the sensors on the system, replacing them with false signals which we may not be able to detect.

Significance: The significance of this work is to prevent process control systems from being attacked. Threats such as those from the Stuxnet worm which has already infected over 200,000 computers and caused 1,000 machines to physically degrade [3], and even caused substantial damage to the Iranian nuclear program [4], shows us how vulnerable the control systems are if there are not sufficient security mechanisms to detect attacks.

Innovation/Forward Thinking: In this work, we will develop methods to detect when process control systems are attacked. We will build mathematical process control model to simulate the ways in which the attack signals enter the system. We can then compare the performance of protected systems to that of unprotected systems subject to the same threats. We will also examine practical considerations for implementing detection and protection methods.

Student Involvement: The student will build mathematical model for process control systems in MATLAB and simulate how attack signals enter the system. He will then show the conditions of the system under attacks. Also, detection methods will be investigated.

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Keywords: System Security, Control Systems, Threat Detection

Project Title: Data Driven Grouping of Building Zones for More Efficient HVAC Control

Faculty Name: Edwin Yaz, Professor, Electrical and Computer Engineering

Student Name: John Burroughs

Introduction: Model Predictive Control (MPC) for Heating, Ventilation and Air Conditioning (HVAC) allows for increased cost savings relative to traditional operating strategies, e.g. schedule-based set-points. When applying MPC to building temperature control, zones controlled by a single piece of equipment are modeled to describe how changing temperature set-points and outdoor air conditions affect the temperature in the zones. [1], [2], [3]

Significance: In a large building, the number of zones can grow to the point that modeling each zone individually makes the resulting MPC optimization problem computationally intractable for use in real-time control. Thus, it becomes beneficial to aggregate zones, provided there is limited impact on accuracy or MPC performance. Each zone has its own set-point and local control, but an air handler will often feed multiple zones. The net effect of changing one zone's temperature set-point on the energy production of the air handler will not be large. Since the MPC is trying to reduce the energy cost of the air handler, the level of detail provided by controlling each zone's set-point individually is unneeded. Some basic reasons that multiple zones may behave similarly are that they are supplied by the same air handler, do not have walls separating them, or share a common exterior wall. There will be some zones that are isolated and behave differently, but many of the zones often behave similarly and a model which describes a group of zones can be defined. If zones are grouped poorly then the aggregate model would presumably not describe the behavior accurately. Therefore, an algorithm that can group models accurately is needed.

Innovation/Forward Thinking: Historical data of indoor air temperatures and set-points provides information about the conditions in which the zones operate. Though this data is large in quantity, it is often not high enough in quality or excitement to provide enough information to generate a model directly. As a result, experiments must be run on the zone to collect sufficient data to create a model. Running these experiments can be costly, and it is preferable to define aggregations before running experiments. A starting point is to use the historical operating conditions as a focal point for grouping the zones. Potentially, these conditions can be converted into features for use in a machine learning problem, directly compared to one another over time, or used to estimate an overall time constant of the zone for grouping. The different groupings can be validated for accuracy using the expert knowledge to say which groups are reasonable, or models can be defined for the zones and the aggregate zones and their predictive accuracy compared.

Student Involvement: I will be responsible for developing the method by which zones are aggregated and for implementing a modeling method for validating results. The work is sponsored by Johnson Controls, which will be a source of data.

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Keywords: Aggregation, Zones, Modeling, Model Predictive Control