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December 3, 2013

Forward Thinking Poster Session/Colloquy Presentation
Past Award Recipients

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 AutismSpectrum: 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, Ferdaus 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

International Research Poster Session
Past Award Recipients

2012

Dr. Dawei Liu
Associate Professor
Dental Developmental Sciences/Orthodontics
"The Mechanism of 'Chinese Traditional Teeth Tapping' in Maintaining Alveolar Bone"

Dr. Iqbal Ahamed
Associate Professor
Mathematics, Statistics and Computer Science
"mHealthMTT: Bridging the Gap in Communication Using a Mobile Based Intervention for Maternal and Child Healthcare in Rural Bangladesh"

2011

Dr. Laura Matthew
Assistant Professor
History
"Circulations: Death and Opportunity in Southern Pacific Mesoamerica, 1450-1620"

Dr. Iqbal Ahamed
Associate Professor
Mathematics, Statistics and Computer Science
“Findings from the deployment of e-ESAS: a remote symptom monitoring system for rural breast cancer patients in Bangladesh”

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

Dr. Eugenia Afinoguenova
Associate Professor of Spanish
Foreign Languages and Literatures

Dr. Ruth Ann Belknap
Associate Professor
College of Nursing

Dr. Irfan Omar
Associate Professor
Theology

Dr. Toni Roucka
Assistant Professor and Predoctoral Program Director of General Dentistry
General Dental Sciences

Table of Contents

COLLOQUY PRESENTERS

INTERNATIONAL POSTER PRESENTERS

FORWARD THINKING POSTER PRESENTERS

PROJECT TITLE: "Mechanisms of Regulation: Profiling Emotion Regulation and its Role in Posttraumatic Stress Symptoms"

FACULTY NAME: Nakia S. Gordon, Ph.D., Assistant Professor, Psychology
STUDENT NAME: Samantha A. Chesney, B.S., Clinical Psychology Doctoral Student

INTRODUCTION

The detrimental effects of trauma are a serious concern for both soldiers and civilians alike. The most well researched consequence of trauma is posttraumatic stress (PTS), which consists of a distinct pattern of symptoms such as increased irritability, frequent intrusive thoughts about the trauma, exaggerated startle response, and avoidance of activities, places, people, or thoughts reminiscent of the trauma. Additional negative effects, such as the inability to effectively regulate one's emotions, have received greater attention in recent years[1,2]. Individuals use a variety of emotion regulation strategies to manage, experience, and express their emotional responses to internal or external stimuli[3]. When a regulatory strategy is used that maintains symptoms or impairs functioning, the regulatory process is maladaptive and can lead to many forms of psychopathology, including PTS[4]. The relationship between trauma, mental health, and emotion suggests that it would be beneficial to better understand the role that emotion regulation strategies might play as risk or protective factors in the development of PTS.

SIGNIFICANCE

Empirical studies have typically limited their investigation to only one or two emotion regulation strategies within a single population[5]. Investigating trauma survivors' use of multiple different strategies, and determining whether there are *profiles* of multiple regulatory strategies, could aid in informing psychological interventions. An emotion regulation profile can be seen as an individual's default pattern of using various regulatory strategies. There is only one study, to our knowledge, that has created profiles of emotion regulation; this study investigated only two regulatory strategies. The intent of this study is to assess participant's use of six different emotion regulation strategies and symptoms of PTS to examine the relationship between these symptoms of trauma and potential difficulties in emotion regulation. This may allow us to pinpoint mediators of PTS symptom reduction and achieve our ultimate goal: to enhance current treatments and facilitate treatment personalization.

FORWARD THINKING/INNOVATION

There is no clear understanding of the range of strategies that can be used to mediate PTS. The current study is innovative because it will respond to the need for answers about trauma survivors' use of multiple different strategies. This study will determine whether complex profiles of emotion regulation exist. We will also determine whether certain patterns of emotion regulation strategies form a key mechanism of action through which a traumatic event leads to PTS by investigating the mediation and moderation effects of this relationship.

Ms. Chesney will extend this study to investigate physical health outcomes related to emotion regulation difficulties after trauma as part of her dissertation. The Inquiries in Affective Science lab will use these data to design experimental studies investigating emotion regulation profiles and emotion challenges.

STUDENT INVOLVEMENT

Ms. Chesney will take the lead on this project with the support of, and in collaboration with, Dr. Gordon. Ms. Chesney has prepared a packet of self-report measures that she will administer to participants recruited from the Milwaukee community. Ms. Chesney is working to facilitate relationships with community partners, and multiple collaboration agreements have been made with sites such as CORE/El Centro Healing Center and Dryhooch coffee shop. Dr. Gordon and Ms. Chesney will conduct advanced statistical analyses on the collected data to determine profiles of emotion regulation and examine the influence of profiles of emotion regulation on symptoms of PTS.

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2. Tull, M. T., Barrett, H. M., McMillan, E. S., & Roemer, L. (2007). A preliminary investigation of the relationship between emotion regulation difficulties and posttraumatic stress symptoms. *Behavior Therapy, 38*, 303-313. doi:10.1016/j.beth.2006.10.001
3. Gross, J. J. (1998a). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2,* 271-229. doi:10.1037/1089-2680.2.3.271
4. Campbell-Sills, L. & Barlow, D. H. (2007). Incorporating emotion regulation into conceptualizations and treatments of anxiety and mood disorders. In J. J. Gross (Ed.), *Handbook of Emotion Regulation* (pp. 542-559). New York, NY: Guilford Press.
5. Aldao, A. (2013). The future of emotion regulation research: Capturing context. *Perspectives on Psychological Science, 8,* 155-172. doi:10.1177/1745691612459518

PROJECT TITLE: "Developing a Construction Cost Estimating application Using Semantic Web Technology"
FACULTY NAME: Saeed Karshenas, PhD, PE, Professor, Civil Engineering/Construction Management
STUDENT NAME: Mehrdad Niknam, M.S. in Construction Management, Doctoral Student in Construction Management

INTRODUCTION

A building construction project is a collection of work items that produce building elements. A work item is considered to be the smallest unit of work for estimating purposes. Cost estimating is the process of analyzing and predicting the cost of performing the work items; it involves collecting all available data about those work items[1] including item quantity and unit costs of the necessary resources. With the advent of BIM technologies, estimators can digitally extract work item quantities from a building model and transfer the data to an estimating application. Current commercial estimating applications allow data exchange with building model applications using proprietary plug-ins. However, the digital data extracted from the building model require humans to understand the data and take proper actions. Also, current estimating applications keep built-in databases of resource unit costs. Since resource costs are affected by economic conditions and continuously change based on supply and demand, estimating applications' unit-cost databases must be manually updated before starting a new estimate which is a very time-consuming process.

SIGNIFICANCE

The process of understanding information that is created in other sources is a human intensive process that requires a high cost of employment of specialized labor[2]. Automating the process of mapping quantities from a building model to estimating assemblies and retrieving resource unit costs from supplier web servers can improve estimator's efficiency tremendously. To achieve this, building model and resource cost data must be published in machine processable formats. Semantic Web[3] technology provides an infrastructure and a data modeling format which enables sharing information on the web in a machine processable format. Semantic Web uses formal ontologies[4] to describe the organization of data on the web. Ontologies can be shared with computer applications to enable processing data that are generated in other sources. The aim of this study is to develop a semantics-based estimating application that retrieves work item quantities from a semantically defined building model and resource cost data from resource suppliers' semantic web services. This estimating approach requires building model, construction processes, and suppliers' product data to be semantically defined; the required ontologies, tools and technologies necessary for this type of development are also investigated.

FORWARD THINKING/INNOVATION

In construction domain, several studies have focused on defining domain ontologies for knowledge management, document management, and Infrastructure concepts. Also, studies have focused on ontologies that describe construction processes, construction material, construction labor and building model. However, there is no previous study that uses ontologies and Semantic Web technology to develop an estimating application. This study is innovative because it investigates how an estimating application can be developed using Semantic Web technology and domain ontologies.

STUDENT INVOLVEMENT

Mehrdad Niknam will take the lead on this project with the support of and collaboration with Dr. Saeed Karshenas. Mehrdad will develop an estimating application that uses Semantic Web technology. The new estimating application requires building model, construction processes and suppliers' product data to be semantically defined and published as semantic web services. This would allow an estimating application to determine work item quantities from a semantically defined building model and resource cost data from suppliers' semantic web services. The required semantic web services will be created as part of this study. The computer program that will be developed in this study will be used in his dissertation.

REFERENCES

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2. Mutis, I., and Issa, R. R. (2012). "Framework for semantic reconciliation of construction project information." ITcon Vol. 17, pg. 1-24.
3. W3C. "Standards: Semantic Web", <http://www.w3.org/standards/semanticweb/> (Oct.28, 2013)
4. W3C. "Standards: Ontologies", <http://www.w3.org/standards/semanticweb/ontology> (Oct.28, 2013)

Project Title: "Comparative Evaluation of Operating Life for Phosphate-Specific Ion Exchange Resins"
Faculty Name: Brooke K. Mayer, PhD, PE, Assistant Professor: Civil, Construction & Environmental Engineering
Student Name: Allen T. Williams, Civil, Construction & Environmental Engineering Master's Student

Introduction

A long-term study of three phosphate-selective ion exchange resins will be conducted to determine phosphate removal performance after at least 15 operational cycles. Ion exchange (IX) for phosphate removal provides excellent wastewater effluent quality and a high concentration phosphate stream for recovery of phosphorus (P), a valuable agricultural resource. Three resins previously shown to selectively remove phosphate from large volumes of wastewater before requiring regeneration for the next operation cycle will be tested, including: LayneRT, Dow-HFO-Cu, and Dow-Cu[1,2]. Fifteen or more cycles of IX and subsequent regeneration will be conducted in column mode using these resins. Secondary effluent filtered and dosed with P will be used as the column influent. Outcomes to be investigated include IX capacity during each cycle, P desorption, metal leaching, and an economic analysis. The goal is to determine the long-term viability of the resins through direct comparison.

Significance

Phosphorus is mined and applied as fertilizer to improve crop yields[3]. This process requires energy and the mineral P may be depleted within the next 50 years[4]. Some of this P is taken up by crops; humans consume the food and excrete P. During wastewater treatment, P is typically removed through settling, biological uptake, and/or precipitation[5]. However, biological removal requires energy to provide microorganisms oxygen and precipitation requires metal salts which affect the fertilizer quality of biosolids[5]. In order to reduce energy and material use for fertilization and wastewater treatment, why not recover phosphate from wastewater for use as a fertilizer? As phosphate rock becomes depleted, recovery of phosphate may become more economical than mining phosphate thereby producing a revenue source for municipalities, benefiting the environment and providing food security[3].

Forward Thinking/Innovation

Testing the resins for multiple cycles provides more information regarding the potential to operate IX at full-scale. Short-term batch and column mode tests of the media have been conducted, but no long-term testing has been performed. The proposed work will determine the ability of the resin to maintain performance over a long period of time. If resins are to be economically favorable for use in wastewater treatment plants, the media must be able to remove P for many operational cycles. Running columns for 15 or more cycles will provide the change in IX capacity over time. This data can be extrapolated to longer periods of time as the rate of change should remain constant after steady state conditions have been reached following the first few IX cycles. Additionally, an economic analysis including capital cost, operational cost, and resin life span can be conducted to determine the most financially favorable media.

Student Involvement

Allen Williams will be the lead on the IX column testing with support and collaboration from Dr. Mayer. Mr. Williams will operate and maintain the column apparatus. An undergraduate student will help Mr. Williams in collecting and preparing sample, measuring sample constituents, and measuring influent and effluent phosphate. Mr. Williams and Dr. Mayer will be responsible for data analysis and dissemination of the results.

References

1. Sengupta, S., & Pandit, A. (2011). Selective removal of phosphorus from wastewater combined with its recovery as a solid-phase fertilizer, Wat. Res., 45, 3318-3330.
2. Zhao, D., & Sengupta, A. K. (1998). Ultimate removal of phosphate from wastewater using a new class of polymeric ion exchangers, Wat. Res., 32(5), 1613-1625.
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5. USEPA (2010). Nutrient Control Design Manual. EPA/800/R-10/100, Cincinnati, OH.

PROJECT TITLE: "How Antibiotic Resistant Bacteria Can Arise in Wastewater Treatment and Techniques For Mitigation"

FACULTY NAME: Patrick McNamara, PhD, Assistant Professor, Environmental Engineering;
Daniel Zitomer, PhD, PE, BCEE, Professor, Environmental Engineering
STUDENT NAME: Daniel Carey, MS, Engineering Doctoral Student

INTRODUCTION

'Antibiotic resistance' refers to the ability of bacteria to survive exposure to an antibiotic drug. Every year in the United States more than 2 million people acquire serious infections from antibiotic resistant bacteria which results in approximately 23,000 deaths (*1*). Antibiotic resistant bacteria emerge due to the continued—and necessary—use of antibiotics. Antibiotic resistant bacteria stem from human households, animal farms, and hospitals. Recently, wastewater treatment systems have been shown spread antibiotic resistance (*2*). Medications and common over the counter personal care products, such as hand soap and deodorant which contain antimicrobial agents, commonly accumulate in municipal wastewater treatment solids handling systems (*3*). Many of these materials pass through anaerobic digestion, a biological wastewater treatment process that relies on a dense biological community of bacteria to degrade wastewater solids. Since antimicrobials typically are not biologically degraded by these bacteria, the bacterial community develops resistance to the deleterious effects of the antimicrobial compounds. Moreover, acquiring tolerance for one type of antimicrobial can lead to resistance to multiple other antimicrobial compounds (*4*). As the live anaerobic bacteria grow it becomes necessary to remove some of bacteria to allow space for new waste to enter the reactor. Approximately half of the material (bacteria and broken down waste products) removed from anaerobic digesters in the United States are distributed to agricultural land as a soil amendment because of its value as a fertilizer. While land application of this product helps to make wastewater treatment sustainable, it may also provide a route for antibiotic resistant bacteria into the environment and increase potential for human exposure.

SIGNIFICANCE

The goal of this research is to understand how the use of antimicrobial agents in common household products affects antibiotic resistance proliferation in anaerobic wastewater treatment systems. In this study experiments will be designed to test the effects of triclosan and triclocarban, the two most abundant antimicrobials found in wastewater treatment system, on antibiotic resistance in anaerobic digesters (*5*). When bacteria acquire resistance to triclosan they can acquire cross-resistance to other antibiotics. In this study we aim to determine if antibiotic resistance will proliferate at a higher rate if the triclosan and triclocarban concentrations increase in wastewater treatment systems. Additionally, we aim to determine how antibiotic resistance proliferation will change if these chemicals are banned from the market. Lastly, we aim to develop treatment methods to mitigate distribution of antibiotic resistant bacteria to agriculture through thermal treatment of biosolids.

FORWARD THINKING/INNOVATION

Many of our current medical practices rely on controlling infectious diseases through the use of antimicrobials. The use of antibiotics leads to antibiotic resistance, and antibiotic resistance proliferation can only be stopped by discontinuing the use of antibiotics and antimicrobials. This cause and effect relationship, however, creates a paradoxical situation in where continued use of antibiotics will continually decrease their effectiveness. Since antibiotics are essential for health care and discontinued use is impractical, we must mitigate proliferation of antibiotic resistance to the lowest sustainable levels by alternative means. Understanding and deterring the proliferation of antibiotic resistance by simple changes in wastewater treatment can allow for the medical field to continue beneficial use of antibiotics. This type of forward thinking is necessary for sustainable practices in the healthcare field.

STUDENT INVOLVEMENT

Dan Carey will design and execute experiments associated with this project under the guidance and collaboration of Dr. Patrick McNamara and Dr. Daniel Zitomer. Master's students and undergraduates in civil and environmental engineering will assist with experimental setup, monitoring, and data collection.

REFERENCES

1. Center for Disease Control and Prevention, "Antibiotic Resistance Threats in the United States, 2013". U.S. Department of Health and Human Services.
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Multisport/Triathlon Program as a Mechanism to Promote Self-determined Exercise Among an Over Weight Inner-city Middle School Latino Population

Faculty: Dr. Paula PE Papanek, PhD, MPT, LAT, FACSM; Associate Professor of Physical Therapy; Program Director, Exercise Science; Graduate Program Director, CTRH

Students: Jeffrey Condit, Exercise Physiology '13, CTRH MS Student; Mark Caballero, Exercise Physiology '14, CTRH MS Student

INTRODUCTION/SIGNIFICANCE

Pending IRB approval, the purpose of this study is to determine if the use of multisport and triathlon based fitness and education programming will positively affect the quantity of exercise and motivation to exercise among a population of Latino middle school students compared to those receiving boot camp-like intervention programming and those receiving no intervention programming. This study will fill holes in previous research in hopes to identify factors in physical activity programming that will lead to self-sustaining increases in both structured and leisure physical activity levels, an outcome measure that is thought to be more indicative of successful intervention, behavior change, future activity levels, and future health measures.

FORWARD THINKING/INNOVATION

1. Do children/parents report higher levels of activity on PAQ-C (Physical Activity Questionnaire for Older Children)?

2. Do children score higher on BREQ-2 (Behavioral Regulation in Exercise Questionnaire)?

3. Does Actigraph monitor data suggest higher activity levels upon termination of the program compared to baseline measurements?

4. Do children score higher on DAP (Developmental Assets Profile) and selected YRBSS questionnaires?

5. How do the above variables correlate with participation in the program?

If successful, we will be able to produce a 'manual' for the installation of a comprehensive school based multisport team/league program that leads to increased self-determined exercise. We hope to understand what combination of elements are necessary in a guided fitness program to create sustained self-directed exercise upon termination of the program, specifically in at-risk/over weight/obese inner city hispanic middle school population. The results of this study will add to the standards of 'best practice' in creating a protocol for weight management programs for inner-city minorities.

STUDENT INVOLVEMENT

Project design, data collection, and data analysis to be done the two graduate students involved. Supervision and advising provided by Dr. Papanek.

REFERENCES

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Thogersen-Ntoumani, Cecilie, and Nikos ntoumanis. "The role of self-determined motivation in the understanding of exercise-related behaviours, cognitions and physical self-evaluations." Journal of Sports Sciences. 24.4 (2006): 393-404. Print.

Henderson, Melanie, Denis Daneman, Janet Hux, and Anthony Hanley. "Exercise Interventions in Obese Youth: Are They Effective?." Journal of Pediatric Endocrinology and Metabolism. 21. (2008): 823-826. Print.

PROJECT TITLE: "Using Spatial Normalization and Correlations Induced by the SENSE pMRI Model to Optimize MRI RF coils for fcMRI Studies in Specific Brain Regions"

FACULTY NAME: Daniel B. Rowe, Ph.D., Professor of Mathematics, Statistics and Computer Science
STUDENT NAME: Iain P. Bruce, Doctoral Candidate in Mathematics, Statistics and Computer Science

INTRODUCTION

In parallel MRI (pMRI), each coil in a phased array of radiofrequency (RF) coils placed around a subject's head acquires the spatial information of the brain concurrently. The overlap of coil magnetic fields (B-fields) allows one to accelerate data acquisition by sub-sampling the frequency spectrum. This results in coil images that appear to be folded over on themselves, but can be unfolded into a full image using models such as SENSitivity Encoding (SENSE)[1]. In conventional studies that design RF coils for SENSE imaging, each coil in the array is assumed to be symmetric from top-bottom and left-right, and the geometry factor (g-factor), which provides a measure of the noise amplification in images due to the overlap of coil B-fields, is the de-facto metric for assessing the array's geometry. Recent studies have shown that the SENSE model's unfolding process artificially induces a non-biological correlation between the folds of an unfolded image[2]. As the SENSE model uses coil B-fields for spatial localization in the unfolding process, it is by definition a function of coil geometry, and thus a more informed RF coil design approach would incorporate a metric that simultaneously optimizes both the g-factor and the SENSE induced correlations within a regions of interest (ROI). Additionally, the human brain is not fully symmetric, and ROIs associated with common degenerative brain disorders are rarely in the very center of the brain. If an ROI specific to a functional connectivity MRI (fcMRI) study is off-center, an optimal array is more likely to be achieved if the constraints on coil symmetry are removed, allowing for individual coils to vary in shape and size. This study proposes a novel approach for determining arrays for specific brain regions by using spatial normalization with sine and cosine basis functions to morph an array of rectangular coils into an optimal arrangement.

SIGNIFICANCE

Within the past five years, over $135m has been dedicated to developing the field of fcMRI in an effort to better understand the human brain. Most fcMRI studies employ a conventional "birdcage" array of fully symmetric rectangular coils, which for an off-center ROI in an fcMRI study may generate unfavorable B-fields. Such B-fields will lead to an increase in both the amplification of noise within the ROI and the non-biological correlations induced about that region through the SENSE unfolding process. As the estimation of low frequency correlations between regions of the brain is the mechanism for deducing functional connectivity[3], such artificial correlations can result in regions appearing to be either correlated or uncorrelated when they are not. Given the tremendous increase in both attention and funding devoted towards fcMRI studies, there is a natural need for the development of RF coils using a joint cost function. An array designed with a low g-factor will have a minimal noise amplification within an ROI of SENSE reconstructed images, while an array designed to minimize the SENSE induced correlations will reduce the influence of artificial correlations in fcMRI studies that analyze those images.

FORWARD THINKING/INNOVATION

The approach of this study is innovative in three ways. First, the ultimate goal in most RF coil design studies is to produce an array with a low average g-factor throughout the brain, and thus the notion of removing the constraints on coil symmetry to design an array optimal for a specific brain region is novel in and of itself. Second, while spatial normalization is typically used to systematically morph images of the brain from a group of patients until the brain regions of all subjects are in the same spatial locations, its use in morphing an array of rectangular RF coils into an optimal geometry is an original application. Finally, the sole aim of most studies that develop RF coils and adaptations of pMRI models is to generate "appealing" reconstructed images that are free of artifacts, with little to no regard as to the correlations that such models induce. This makes an optimization criteria in which both the g-factor and SENSE induced correlations are simultaneously minimized a novel approach to improve the reliability and accuracy of conclusions drawn in fcMRI studies.

STUDENT INVOLVEMENT

With the support of his advisor, Dr. Daniel B. Rowe, and that of Dr. L. Tugan Muftuler at the Medical College of Wisconsin, Mr. Bruce will determine an approach to morph an array of coils using spatial normalization, theoretically determine a new coil design cost function, and finally use that function in a stochastic optimization algorithm to derive the basis function coefficients of optimal arrays for specific brain regions. Mr. Bruce will pilot his analysis in MATLAB, and perform a final analysis of optimal arrays using a high frequency structural simulator.

REFERENCES

1. Pruessman et al., Magn. Reson. Med., 42; 952-962, 1999.
2. Bruce et al., Magn. Reson. Imag., 29; 1267-1287, 2011.
3. Biswal et al., Magn. Reson. Med., 34; 537-541, 1995.

PROJECT TITLE: Quantification and Utilization of the Statistical Effects of Spatio-Temporal Processing of fcMRI and fMRI data in Computing Functional Connectivity and Cognitive Brain Activation

FACULTY NAME: Daniel B. Rowe, PhD, Associate Professor, Department of MSCS.

STUDENT NAME: M. Muge Karaman, PhD Candidate, Department of MSCS.

INTRODUCTION

Functional MRI (fMRI)[1] and functional connectivity MRI (fcMRI)[2,3] have become two of the most popular non-invasive areas of brain mapping research that study brain activity and brain connectivity. The primary forms of fMRI and fcMRI use the blood oxygenation level dependent (BOLD) contrast that is based on the hemodynamic response related to energy use by brain cells. In fMRI, the cortical and subcortical regions that have a BOLD signal correlated with the task are assessed and considered as functionally activated. In fcMRI, the temporal correlations in spontaneous BOLD signal oscillations are detected while subjects rest quietly in the scanner. In both fMRI and fcMRI, the various sources of noise, such as physiological, thermal, system noise and random neuronal activity during the task performance, corrupt the measured BOLD signal. As such, many studies have aimed to attenuate the noise in reconstructed images through spatial and temporal data processing operations. Although such processing improves the appearance of the data, many commonly used processing operations induce artificial correlations in the acquired data. If the statistical implications of such processes are not accounted for in the given fcMRI and fMRI models, they can lead to misleading and inaccurate brain activity and connectivity conclusions drawn from the data.

SIGNIFICANCE

Recent studies[4,5] show that the use of spatial processing operations, such as spatial filtering in the spatial frequency space and/or image space, results in induced artificial correlations between previously uncorrelated voxels (volume elements) of the reconstructed images. However, the traditional fMRI and fcMRI models assume independence between voxels and therefore do not account for the spatial correlation between voxels or temporal correlation within each voxel's time series. As these induced correlations are of no biological origin, they may result in increased false positive rates in fMRI and fcMRI. Even though the induced correlations can be estimated with the use of time consuming simulations, in an effort to accurately quantify these implications, a mathematical model that allows one to theoretically determine the effects of each processing individually or all processes collectively remains in need. Furthermore, ideal methods for computing functional connectivity and cognitive brain activation should allow the statistical implications of data processing to be included into the final analysis. The goal of this study is to (*i*) develop a linear framework that represents each spatial and temporal processing operation as a linear matrix operator in order to precisely quantify the correlations induced by such processing, and (*ii*) expand the current fcMRI and fMRI models to incorporate an analytically derived spatiotemporal covariance structure of processed time series for more accurate and reliable functional connectivity and cognitive brain activity results.

FORWARD THINKING/INNOVATION

The proposed framework will provide a tool for neuroscientists to analytically quantify artificial correlations that are induced into the data, and characterize excessive processing. The incorporation of the exact image-space statistics into fcMRI and fMRI models will improve accuracy and reliability of the functional activation and functional connectivity statistics. The tools and models that we aim to develop will ultimately contribute to the diagnosis of neurological disorders and the improvement of the accuracy of neurosurgical planning. Furthermore, the development of the proposed framework will provide a significant step for achieving Rowe Lab's primary research goal of developing a unified mathematical model for fcMRI and fMRI, and therefore will facilitate future studies.

STUDENT INVOLVEMENT

Under the supervision of Dr. Rowe, the doctoral candidate M. Muge Karaman will take the lead in this project, including the development of the mathematical framework, representing the commonplace temporal processing operations in terms of linear isomorphisms, expanding the current fcMRI and fMRI models to account for the statistical impacts of spatial and temporal processing, and implementation of the proposed framework in MATLAB.

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PROJECT TITLE: "The PEERS Intervention: Examining Long Term Effects on Social Skills, Social Anxiety and Physiological Regulation in Adolescents with Autism Spectrum Disorders"

FACULTY NAME: Amy Vaughan Van Hecke, Ph.D., Assistant Professor of Psychology & Director of Marquette Autism Clinic and Project

STUDENT NAME: Kirsten A. Schohl, M.S., Adjunct Instructor & Clinical Psychology Doctoral Candidate

INTRODUCTION

The number of youth diagnosed with Autism Spectrum Disorder (ASD) has increased dramatically over the past decade and currently affects approximately 1 in 88 children in the U.S.[1] Those with higher functioning autism display marked impairments in social skills[2]. These social deficits are problematic, especially during adolescence, when the demands of peer relationships and social network affiliations become heightened[2]. Adolescents with autism have been found to significantly report more social anxiety symptoms and have more physiological arousal than their typically developing peers,[3,4] which in turn negatively affects their minimal social skills. An intervention titled the Program for the Education and Enrichment of Relational Skills (PEERS) was recently developed, in order to teach adolescents with autism the social skills necessary to make and keep friends[6]. However, it is unknown whether and how this brief intervention affects anxiety and physiological arousal in adolescents with ASD over the long-term.

SIGNIFICANCE

Adolescents with high functioning autism are a highly neglected group in terms of services offered. There are minimal effective treatments that are geared towards this population in relation to helping with social skills or decreasing anxiety. Fortunately, PEERS has proven to be effective in improving social skills, although its potential effects on adolescent social anxiety and physiological arousal have not yet been assessed. In addition, the long term outcomes of PEERS have not yet been studied, so maintenance of positive effects of the intervention is unknown. Therefore, this study will collect data at three different time points, namely pre-PEERS, post-PEERS and 6-months following participation in PEERS. This study aims to evaluate the effectiveness of the program in the maintenance of social skills as well as to assess the effect that intervention may have on the plasticity of physiological regulation of heart rate and social anxiety.

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the challenges that adolescents with autism face and aims to improve and better understand those challenges. The piece of this study that is particularly innovative is the assessment of physiological arousal in relation to a social skills intervention, which has never been conducted before. Specifically, it is unknown to what degree the intervention itself, which focuses on social attention and interaction, requires or results in a mobilization response. Therefore, it could be that arousal is heightened during the intervention, when the topics addressed are new and challenging for the adolescent, but that arousal decreases after the intervention concludes and the topics become part of the adolescent's natural repertoire. This study will aim to answer whether or not participation in intervention affects the plasticity of physiological autonomic arousal, via respiratory sinus arrhythmia (RSA). This study has the potential to have significant implications in the development of future interventions and will lead to a better understanding of physiological responses to intervention in autism.

STUDENT INVOLVEMENT

Kirsten Schohl, M.S. will take the lead on this project with the support of and collaboration with Dr. Amy Vaughan Van Hecke and the Autism Lab. Ms. Schohl will help in the process of recruiting participants. She will also plan and organize all 6-month follow-up appointments. Ms. Schohl will participate in data collection at pre, post, and 6-month follow-up appointments. She will train undergraduates in all aspects of heart rate data editing and oversee all heart rate data collection. Ms. Schohl will lead one of two PEERS treatment groups. This study will then be utilized for her dissertation and will facilitate future research.

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PROJECT TITLE: Failure Mechanism of FRP Debonding from Concrete Beams
FACULTY NAME: Baolin Wan, Ph.D., Associate Professor, Civil Engineering
STUDENT NAME: Tayyebeh Mohammadi, Ph.D. Student, Civil Engineering

INTRODUCTION

The functions of building and bridge structures may become gradually weaker due to long term use, environmental deterioration, poor initial design and construction, increased occupied or traffic loads, extreme events such as earthquakes, and lack of maintenance. The Federal Highway Administration (FHWA) reported that over 27% of bridges in service in the United States are deficient and needed retrofitting and strengthening. The cost to maintain the nation's bridges during the 20-year period from 1999 to 2019 is estimated to be $5.8 billion per year, and the cost to improve and eliminate deficiencies over the same period is $10.6 billion [1].

Fiber-reinforced polymer (FRP) composite materials are comprised of high strength fibers (e.g., glass or carbon fibers) embedded in a polymer matrix (e.g., epoxy). Outstanding material properties of FRP composite include: high strength, high stiffness, excellent corrosion resistance, chemical stability for both alkaline and acidic environments, lightweight, simplified construction, low labor cost, short construction period and few interruptions to service [2]. Due to their excellent properties, using external bonded fiber-reinforced polymer (FRP) composite systems to retrofit or strengthen concrete bridges and other infrastructures become more and more popular in the last two decades [3].

The major failure mode of FRP strengthened concrete beams is FRP debonding from concrete before FRP reaches its ultimate strength, and this failure mode has not been fully understood yet. In this project, FRP bonded concrete beams will be tested in the Engineering Materials and Structural Testing Laboratory (EMSTL) in the brand new Engineering Hall. The experimental data and observations will be used to establish a finite element analysis (computer simulation) model. Then the computer model will be used to perform a parametric study to reveal the failure mechanism of FRP debonding from concrete beams.

SIGNIFICANCE

Current design codes in the US and other counties use empirical equations to design FRP strengthened concrete beams [2]. These equations are best-fit of experimental data and are far away from the real science. In order to improve design recommendations, debonding phenomena must be addressed in a fundamental manner. The next generation of design guidance must be founded on a fundamental mechanics approach to the interfacial problem rather than on empirically derived "best fits". This proposed project is a critical step to this direction.

FORWARD THINKING

Most researchers use a simple pull out test, in which the FRP/concrete interface is subjected to pure shear force, to study FRP debonding from concrete in beams. However, the FRP/concrete interface is subjected to very complex stresses other than pure shear force in the real beams. Therefore, the simple pull out test can not reveal the true failure mechanism. The experimental testing and computer modeling of real FRP strengthened concrete beams proposed in this project will provide more fundamental understanding of FRP bebonding in the strengthened concrete beams. The results of this project will help to generate proposals to seek external funding from NSF, American Concrete Institute (ACI) and the industry to further study this problem to improve the Codes to design and construct safer and more durable FRP repaired concrete bridges and other structures.

STUDENT INVOLVEMENT

Tayyebeh Mohammadi, who is a PhD candidate in Civil Engineering, is going to design and perform the experimental test. She will also use the experimental data and observations to build computer models to predict the debonding failure behavior in the FRP strengthened concrete beams.

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PROJECT TITLE: "Recovering from Foreclosure: An Experimental Study of a Community Outreach Campaign"
FACULTY NAME: Amber Wichowsky, PhD, Assistant Professor of Political Science
STUDENT NAMES: Colleen Ross and Anabelle Martinez (Fall 2013) and members of POSC 4281 (Spring 2014)

INTRODUCTION

Between 2008 and 2010, nearly 16,000 homeowners in Milwaukee—most of them located on the city's northwest side—were notified that they had defaulted on their mortgages, resulting in a foreclosure rate that by 2010 was double the city's historical average.[1] The Harambee neighborhood, located just north of downtown, was hit particularly hard by the collapse of the housing market. As of 2012, the median home price in the neighborhood had decreased by more than 50 percent compared to 2007. Fearing further deterioration in communities that already had high poverty and lower housing quality prior to the foreclosure crisis, Milwaukee created the Targeted Investment Neighborhood (TIN) initiative to stem—and even reverse—housing blight in the city's poorest neighborhoods. Milwaukee's TIN program offers residents and landlords forgivable, low-interest, and deferred payment rehab loans. ACTS, a nonprofit organization, has created similar programs to encourage housing investment and rehabilitation in the Harambee neighborhood. Despite their good intentions, these programs remain underutilized. Landlords—many living outside of the targeted neighborhoods—fear being hit with housing code violations if they apply for these funds. To address this problem, the Harambee Great Neighborhood Initiative (HGNI) is looking to conduct community outreach to increase program uptake. Students from Dr. Wichowsky's class on Urban Public Policy (POSC 4281) will be partnering with HGNI to conduct a randomized field experiment testing the effectiveness of a campaign to increase participation in these housing rehabilitation programs.

SIGNIFICANCE

Housing blight creates a number of externalities, including increased crime,[2] higher rates of residential turnover,[3] and a reduced "sense of community."[4] It is also contagious: run-down and abandoned units detract from the desirability of neighborhoods, which in turn reduces housing demand and investment.[5] Neighborhood stabilization is thus a key priority for Milwaukee and remains a fundamental urban policy challenge for many U.S. cities.

FORWARD THINKING/INNOVATION

Dr. Wichowsky has recently joined with political scientists from Notre Dame, The Ohio State University, and Yale University, among others, to form the "Laboratories of Democracy (LoD) Project," a nonpartisan endeavor dedicated to improving government in the U.S. LoD partners with public officials and community stakeholders to help them implement randomized control studies to evaluate various programs and policies. Unlike typical consultants, LoD uses experiments to measure the effectiveness of interventions. Further, LoD shares the results of its studies so that public officials and nonprofit organizations can learn from each other. Next semester, Dr. Wichowsky will be establishing a regional lab at Marquette, where students will partner with community stakeholders to conduct experimental studies of pressing policy challenges. This project is the first in what is envisioned to be several studies that touch on a broad array of urban issues, from civic engagement to water conservation. With its focus on community engagement and high-impact educational practices, "Marquette's Democracy Lab" will contribute to several goals in the University's new strategic plan.

STUDENT INVOLVEMENT

Students from POSC 4281 will be partnering with HGNI to conduct a community outreach campaign. Students will learn about the effects of housing blight on individual and community wellbeing and examine housing policies intended to combat neighborhood deterioration. Students will also develop their research and analytical skills by helping to design, implement and analyze a field experiment to test the effectiveness of their campaign. Two students are currently working with Dr. Wichowsky to gather background program information and identify the study population. In addition to designing the campaign and implementing the field experiment, students will produce policy reports, write blog posts for "Marquette's Democracy Lab," and present their findings to public officials and other community stakeholders.

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PROJECT TITLE: "Anaerobic membrane bioreactor for sustainable wastewater treatment"
FACULTY NAME: Daniel Zitomer, Ph.D., P.E., BCEE, Professor of Civil, Construction and Environmental Engineering and Director of Water Quality Center
STUDENT NAME: Matt Seib, MS, RPCV, Civil, Construction and Environmental Engineering Doctoral Candidate

INTRODUCTION

In the past, wastewater was viewed as a harmful byproduct that needs to be mitigated. Conventional management of low strength, municipal sewage relies on aerobic biotreatment processes such as activated sludge. These processes require large facility footprints and energy inputs for aeration, produce high volumes of residual biosolids and remove, rather than recover nutrients such as nitrogen and phosphorus. These processes are not sustainable because they are energy and resource intensive and do not reuse or recycle constituents in wastewater.

SIGNIFICANCE

Current strategies for wastewater treatment now view wastewater as a resource to be utilized[6]. Wastewater treatment scenarios for cities of the future focus on sustainability by placing an emphasis on reducing energy requirements and biosolids production, recovering nutrients such as nitrogen and phosphorus, capturing stored chemical and thermal energy, and re-using treated water by replacing aerobic systems with anaerobic biotechnology[3,7]. One fault of new sustainability paradigms is that anaerobic biotechnology is shown as a "black box" that is assumed to be technically feasible, but has yet to be demonstrated in full-scale applications for municipal wastewater. A potential significant drawback is that anaerobic processes are typically done at warm temperatures (20-55 ^{o}C), which can require a large energy input for heating in cold climates[2]. However, recent developments in anaerobic treatment have focused on operation at low (psychrophilic) temperatures[4], which reduces the need to heat wastewater. Other recent improvements have focused on utilizing membrane filtration as a way to stabilize the biological process and improve effluent quality from the bioreactor[1,5], but these studies have not focused on reducing energy demands from pumping/mixing in the bioreactor.

FORWARD THINKING/INNOVATION

This study is innovative because it seeks to answer questions about assumptions inherent to the "black box" idea of using anaerobic treatment for sustainable municipal wastewater treatment. The project includes the construction and operation of a pilot-scale anaerobic membrane bioreactor equipped with nutrient recovery technology. A novel bioreactor configuration will be employed that will provide insight into the ability to simultaneously reduce energy inputs for heating and pumping while attempting to achieve regulatory effluent standards for treated wastewater at cold temperatures.

STUDENT INVOLVEMENT

Matt Seib will be responsible for managing operation and data collection of the pilot-plant anaerobic membrane bioreactor. He will oversee daily maintenance, work with another graduate student studying the nutrient recovery portion of the project, guide undergraduate assistants who will help operate the pilot plant, and compile and analyze performance data with Dr. Zitomer. This study will be the basis for Mr. Seib's doctoral dissertation.

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PROJECT TITLE

Designing Human-Computer Interfaces for Elderly People in Taiwan

FACULTY

Dr. Sheikh Iqbal Ahamed, PhD, and William Chu, PhD

STUDENT NAME

Drew Williams, Mohammad Arif Ul Alam

INTRODUCTION

As computing devices continue to become more heavily integrated into our lives, proper design of human-computer interfaces becomes a more important topic of discussion. Efficient and useful human-computer interfaces need to take into account the abilities of the humans who will be using such interfaces, and adapt to difficulties that different users may face – such as the difficulties that elderly users may face compared to younger ones. As people grow older, they see a natural decrease in visual, auditory and cognitive abilities. Motor skills also see a decline; in a survey taken of elderly computer users for a study in coaching older users to properly use a computer, issues with dexterity and computing were most often reported, only tied with fear of making a mistake. [1] However, elderly people - especially those in Taiwan, as an example - are some of those who might benefit most from computers that are designed to accommodate their abilities. We propose a new operating system interface be developed for elderly people that adapts to their habits, simplifying the interface based on a user's abilities. On startup, the interface would take an assessment of the user's mobile, visual, auditory, memory and motor skills via a quick, easy-to-understand questionnaire. A profile would be built based on the responses to these questions, similar to the SUPPLE project [2], but encompassing not only mobility, but memory, hearing and visual abilities as well. The questionnaire would be designed to take as little time as possible - further inferences about user ability could be made by monitoring the user's interactions with the interface. Depending on a users' actions, icons might be resized, contrast might be increased, alerts might shift in pitch and windows might resize to be closer together or grouped in a particular portion of the screen. Furthermore, tutorials would tell the user what actions they have taken, and what actions they need yet to take: this way, a user can develop a conceptual model through repetition, which is better alternative than memorization [3].

SIGNIFICANCE

For elderly people in particular, software and hardware which actually might help them is often rejected by them because of problems with the user interface. For example, an elderly person might use social networking websites – such as Facebook, or Twitter - in order to stay in touch with their children and grandchildren. However, multiple menus hiding various settings, coupled with colorful designs, can often hinder efforts to use these social networks – the elderly often have less sensitivity to contrasts in color, and multiple patterns run the risk of confusing a user [5]. The creation of a user-interface aimed at simplifying the user experience for the elderly would allow them to use software and hardware that might greatly improve their quality of life.

FORWARD THINKING/INNOVATION

While a number of different examples of human-computer interfaces designed for those with disabilities exist, none exist that take into account particular difficulties encountered by those of older ages. Furthermore, solutions are often tailored to one or two disabilities in particular - such as SUPPLE [2] or Eldy, software that vastly simplifies the user interface of a PC to one that displays several large, easy-to-read buttons that allow a user to read mail, surf the internet, chat/use Skype, and more [6]. Our solution works to adapt more portions of the interface than other solutions, and integrates tutorials for a helpful learning experience as the user uses their computer.

STUDENT INVOLVEMENT

Drew Williams is currently working on developing a plan for technical development of such a human-computer interface, in addition to supplementing her existing knowledge with current trends in human-computer interfaces and adaptive interface design. M. Arif Ul Alam has developed a plan for a fall prevention app that takes these design principles into account, in an effort to make the application more useful for elderly people.

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Tokens in a Man's World: A Global Analysis of Women in Advertising Creative Departments

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Abstract

Women drive 80-85% of all consumption decisions (Grow and Broyles, 2011; Grow, Roca and Broyles 2012; Mallia 2009a and Windels and Lee 2012). Thus, it would seem logical that robust female representation within advertising creative would be a business imperative, driven by client demand. Yet, that does not seem to be the reality of global advertising.

Underrepresentation or segregation of women is not unique to advertising creative departments. It is, in fact, common within the global workforce. However, it presents a challenge for an industry, which is highly affected by female purchase decisions.

Previous studies indicate that women have a fair presence in advertising agencies overall. However, it appears that women make up only a small percentage of creative teams and are often excluded from senior creative positions. Research on this topic has been predominately Western. For instance, Klein (2000) explored female representation in Britain and Sweden and found that females represented just 15% and 30% (respectively) of those in creative. *Advertising Age's* 2005 report on agency employment, focusing on the United States, demonstrated a consistent trend of underrepresentation of women in advertising creative: 32.0% in 2003, 31.9% in 2004 and 31.3% in 2005.

The current study is the first study to quantatively address the underrepresentation of women using industry data, with the 2013 *Standard Directory of Advertising Agencies*. The data includes 1,915 agencies from 50 countries and represent 3,041 Creative Directors, Art Directors and Copywriters from across the world.

The theoretical frames that anchor this work are two multidimensional models using both horizontal distribution (creative staff) and vertical distribution (creative management). Applying the Hofstede and GLOBE models data demonstrate fairly consistent patterns across cultural differences.

Findings confirm token status for creative women in management at 14.6% globally; while women comprise only 20.3% of all creatives across the world. The relationships between gender and the role of Creative Director on a global scale, as well as in three regions (Europe, Asia Pacific, Africa and Middle East) suggest that vertical and horizontal segregation is solidly entrenched. The United States may be considered a bright spot with 27.7% creative women, and a hopeful 25.2% female Creative Directors. Yet, not a single country, which would be considered a major international advertising force, reaches the 35% benchmark for proportional representation. This global lack of proportional representation suggests creative women rarely achieve impactful positions in advertising creative anywhere in the world. Further, 16 countries fall below the 15% token threshold.

These numbers suggest a powerful marginalization of women in advertising creative. More troubling for an industry that is predicated on speaking with resonance to consumption decision makers, 80-85% of whom of female, is the fact that women are not even proportional represented in advertising creative departments across the world. The lack of women in creative is not just bad for advertising, it is bad for society and it is bad for business.

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UNTOLD STORIES: AN AFRICAN SOCIETY AND THE SECOND WORLD WAR (NIGERIA)

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Studies on the Second World War have not particularly focused on the contributions of African societies, the impact of the war on their lives and the role they played in shaping the course of history. A main actor in the event is Britain. In this project, I analyze the actions taken by Britain to garner support and elicit the commitment of Nigerians—her colonial subjects— to support the war efforts of Britain and her allies. The study examines the struggles of the African population to survive the depressed economy of the war and the strategies they adopted to cope with the crisis it engendered, and the contributions of Africans towards the British and Allied war effort. It is a study that uses an unusual but critically important source left by the African population—in the form of petitions and supplications written by Nigerians during the war. This unique documentary source has never been used by scholars. The project fills an important gap in the history of the Second World War in relation to colonial history. It challenges the dominant Western-centered narrative of the war that laid less emphasis on the contributions of the African people and the impact of the war on their societies as illustrated with the Nigerian example. With its focus on the Humanities as a whole, this work will contribute to all areas of colonial studies including cultural studies, histories of cultural encounters, and indigenous literary traditions from diverse viewpoints.

A CROSS-CULTURAL STUDY OF CORPORATE SOCIAL RESPONSBILITY COMMUNICATION: CHINA VS. TURKEY

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Graduate Student

Abstract

The issue of corporate social responsibility has become more complicated than ever before. At the heart of the concept of corporate social responsibility (CSR) is the relationship between business and society (Wood, 1991). Values of a society are often culturally based (Triandis, 1995; Hofstede, 2001). This study is interested in country- or societal-level culture influences on CSR values in higher education as manifested in university website communication with stakeholders. In particular, the study examined CSR communication of top 100 Chinese and top 100 Turkish universities. We argue that some cultural characteristics may foster, while other diminish CSR values, which in turn will reflect on CSR communication. A quantitative content analysis of the university websites was conducted based on a coding schema. The results of the analysis showed that university websites in both countries communicated a sense of CSR to a certain extent, however many differences were found in the types of responsibilities communicated and emphasized as the most important. Specifically, Chinese gave transparency and economic responsibilities more weight than did Turkish universities. Findings showed that most Chinese universities' website have either or both of the categories on the homepage – *Open to the Public* (featuring information about the operation of the university and many reports) and *President's Mailbox* (encouraging people to write letters to the president expressing their concerns or suggestions). Most of the Chinese universities' website has a link to *Alumni Association* and *Education Development Foundation*, which suggested the importance of giving back to the university. It was interesting to note that environmental sustainability, as an important component of CSR, was missing in the Chinese universities' websites. Turkish universities, on the other hand, have emphasized the community relations as the most important part of their CSR activities. The value of the paper rests in its communication of CSR in the context of higher education through a cross-national perspective. With few exceptions, CSR strategy and communication have been examined in the business context in the literature. Thus, by expanding an important component of CSR and placing it in a global higher education context, the paper properly expands on the intersection of education and CSR at an international level.

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PROJECT TITLE

Multi-agent Software Application for Smart Buildings

FACULTY NAME

Cristinel Ababei, Dept. of Electrical and Computer Engr., Marquette University

STUDENT NAME

To be recruited.

INTRODUCTION

Buildings in the US account for about 40 percent of the total energy consumption and greenhouse gas emission. Therefore, making buildings more energy efficient is an important problem to solve, not only in order to reduce the carbon emission to combat global climate change but also to reduce costs. There are primarily two ways to address this problem: the utilization of energy efficient building materials and appliances and the smart building approach. In this project, we focus on the latter.

SIGNIFICANCE

Reducing energy consumption translates into cost savings and reduced carbon emissions.

FORWARD THINKING/INNOVATION

We plan to develop a multi-agent software application for smart buildings. Based on a cross-layer hardware-software co-design approach, the proposed building management system (BMS) continuously monitors the energy consumption patterns of individual zones (e.g., rooms or clusters of rooms) of a building as well as the movement and presence of people inside. The objectives of the application are: 1) To develop occupancy prediction based on the data collected by an embedded network of wireless motion detection and cameras (i.e., existing ambient intelligence support), 2) To develop HVAC (heating, ventilation, and air conditioning) and lighting operation modes based on these predictions, 3) To develop scheduling algorithms for major energy consumption events with consideration of renewable energy sources and storage elements to shift away from peak times and to better match consumption within microgrids to supply.
The primary goals are: 1) To reduce energy consumption and thereby costs and 2) To optimize comfort. A distinguished feature of the proposed BMS includes novel energy reporting services. Aside from the typical graphs and historical traces to present energy consumption, we develop a continuously changing smartphone screen-saver deployed on the smartphones of all building users. Inspired by prior work on user wellbeing, the proposed screen saver displays a forest of animated trees – whose number and color depend on the savings so far. The app's interface provides recommendations to motivate behavioral changes that can lead to energy savings.

STUDENT INVOLVEMENT

The recruited student will closely work with the faculty on all aspects of this project.

REFERENCES

NA

PROJECT TITLE: Recognition of Complex Human Activity on Smartphone
FACULTY: Sheikh Iqbal Ahamed, Ph.D., Roger Smith, Ph.D.
STUDENT: Md Osman Gani

INTRODUCTION

In our everyday life, we perform a lot of actions or events called activities. Activities can be performed both indoors and outdoors for various purposes. We can classify these activities into two classes, one is simple activity and the other is complex activity. Simple activities are walking, running, sitting, lying, climbing upstairs or downstairs, jumping etc. On the other hand complex activities are cooking, washing dish, driving, watching TV, reading a book, playing tennis, swimming etc. It is easy for humans to watch and then detect or understand the activity of another, but building an automatic system to detect a variety of human activity is extremely challenging [1]. Nowadays' Smartphone's are equipped with various sensors such as accelerometer, gyroscope, magnetometer, pressure sensor and proximity sensor [2], [3]. People are using Smartphone every day and everywhere. It offers good computational power, motion-sensing capabilities and at the same time it is relatively low cost [4]. Also it is more comfortable for a user to use smartphone instead of wearing multiple body sensors. Smartphone can be used to predict the ongoing complex activity of its user.

SIGNIFICANCE

Recognition of human activity is a multidisciplinary research area and has importance in many research areas such as Pervasive Computing, Machine Learning, Artificial Intelligence, Human Computer Interaction, Health Care, Medicine, Social Network, Psychology and Sociology. Therefore, it has been a significant area of interest for researchers from various fields. Performing Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) are an important part of living a healthy independent life. These activities cover a wide range, such as self-care, meal preparation, bill paying, and entertaining guests. The ability to perform ADLs and IADLs are important indicators both for those recovering from a newly acquired disability, or for those at risk for decline, either through chronic physical or mental impairments (i.e., ALS, MS, Parkinson's, Alzheimer's), and may act as early indicators of disease or illness. Disruptions in the routine of ADLs can be an indicator of either lack of rehabilitation success, or significant decline in function, and act as an important indicator of a return to or decrease in the quality of life (QoL). These disruptions in routine are often used as signals for those suffering psychological impairments, such as depression and dementia.

FORWARD THINKING / INNOVATION

For this research we have the following objectives 1) classify human activities so that the system can easily distinguish between various activities, 2) identify parameters that influence human activity from a sufficiently large set of data, 3) identify relations between activities and their influential parameters, 4) Classify simple human activities, 5) Classify complex human activities. We developed a tool in Android to collect sensor data for simple activity recognition. It can collect data from all available sensors simultaneously. We will use this tool to generate a data set for different activity in a controlled environment. The developed tool is very generic and it can be used to collect data from a specific set of sensors. We have also collected complex activity data set of 3 persons for 56 days. We will use this data set for the experiments to achieve our goals.

STUDENT INVOLVEMENT

Md Osman is working on design and development of the proposed complex activity recognition system using Smartphone.

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PROJECT TITLE: Physiological Monitoring of Children with Autism Spectrum Disorders (ASD) during PEERS Intervention

FACULTY NAME(S): Sheikh Iqbal Ahamed, PhD, Professor, MSCS and Amy Vaughan Van Hecke, PhD, Assistant Professor, Psychology

STUDENT NAME(S): Niharika Jain, M.S., Computational Sciences Doctoral Student

INTRODUCTION

Autism Spectrum Disorder (ASD) is a group of developmental disorders which includes Autistic Disorder, Asperger Syndrome and Pervasive Developmental Disorders – Not Otherwise Specified (PDD-NOS). These disorders are characterized by abnormal functioning in social interaction, communication, restricted and repetitive behavior. The prevalence rate of ASD has increased from 1 in 150 (in the year 2002) to 1 in 88 children (in the year 2008)[1]. This increase in prevalence rate is not only due to the increase in number of cases of ASDs but also because of more awareness and improvement in diagnostic tools over the years. Early diagnosis of ASD not only helps in improving the development of children with ASD but also helps in preventing the growth of secondary conditions such as anxiety, obesity, and depression.

SIGNIFICANCE

Physiological monitoring can help detect the emotional state of an individual by monitoring his physiological signs such as Electrodermal Activity (EDA), Blood Volume Pulse (BVP), skin temperature etc. EDA varies with change in moisture level of skin surface and hence increases when a person is aroused as in case of anxiety, or nervousness. One of the common signs present in case of children with ASD is that they have trouble expressing their emotions and understanding them. Moreover, anxiety disorders are very common among children with ASD and the prevalence rate has been reported to be between 11% and 84%[4]. Physiological monitoring can help us filter out the situations pertaining to high levels of anxiety. A thorough analysis of these situations can lead to better assessment and intervention plan for children with ASD.

FORWARD THINKING/INNOVATION

In this project, we are trying to find out the situations which cause anxiety among children while undergoing an intervention. We would also like to see if the children are self-aware of the emotional changes they are experiencing during the sessions. It will help us know if they need some kind of prior assistance in coping with anxiety before they are made to go through any kind of intervention. Program for Education and Enrichment of Relational Skills (PEERS)[2] is a social skills training intervention for adolescents and young adults. Although this program in itself has a strong evidence-base for use with teenagers with ASDs[3], the uniqueness lies in using PEERS with the aim of understanding the emotional part of human psyche.

STUDENT INVOLVEMENT

Dr. Amy Van Hecke and her graduate students from Department of Psychology recruit the participants for study, complete the in-take and out-take procedures and conduct the PEERS sessions. Niharika Jain is responsible for collecting data using wearable bio-sensors, video cameras and questionnaires. Once the data collection for the group is complete, Niharika Jain, under the supervision of Dr. Sheikh Ahamed will work on data analysis.

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PROJECT TITLE:

A Real-time Smartphone- and Smartshoe-based Fall Prevention System

FACULTY NAME:

Sheikh Iqbal Ahamed, Ph.D. and Roger Smith, Ph.D.

STUDENT NAME:

AKM Jahangir Alam Majumder, Computational Sciences Doctoral Student.

INTRODUCTION

The problem with accidental falls among elderly people has massive social and economic impacts and dramatic health consequences. In the year 2025 the elderly population is projected to account for 15% of the total population. For people of 70-75 years old, the estimated incidence of falls is over 30 percent per year [1]. Falls not only cause physical injuries, but also have dramatic psychological consequences that reduce elderly peoples' independence [2]. Most advances in gait analysis technology have come through the vision based and floor-sensor based research, but these methods require bulky, expensive equipment and have associated logistical difficulties that limit practicality. Modern smartphones have become a viable alternative to these expensive methods given their advanced motion-sensing capabilities, processing power, and relatively low cost. Though there has been a lot of research on automatic fall detection, the area of fall prevention has been understudied. Therefore, our focus is on fall prevention rather than fall detection. To address the issue of fall prediction, in this poster, we proposed a smartphone- and Smartshoe-based fall prevention system that can alert the user to his or her abnormal walking pattern. The shoe-integrated sensor system with two powerful smartphone sensors—accelerometer and gyroscope—are used in our system to identify abnormal gait or walking patterns in the elderly. The Smartshoe can communicate with the smartphone through a Wi-Fi communication. Since abnormal walking patterns can lead to a fall, the identification of abnormal gait in the system is used to alert the user regarding a potential fall.

SIGNIFICANCE

Scientific research on Smartphone-based fall detection system has recently been stimulated due to the growing elderly population and their risk of falls. In all previous studies, the system can detect a fall only after it has already occurred and the system sends an alarm to the caregivers for immediate help. Even though these fall detection systems are helpful, the best way to reduce the number of falls and their consequences is to prevent them from happening in the first place. We believe that the best way to reduce the number of falls is to alert the users about their abnormal gait/walking and the possibility of falling. The term "gait" refers more specifically to the manner or pattern of walking. Gait and balance disorders are common in older adults and are a major cause of falls in this population. If abnormal walking patterns can be identified using automated processes and with good accuracy, the elderly can be saved from a potential fall. According to our research, we are the first to propose a fall prevention system that detects users' abnormal gait patterns by monitoring the user' daily activity to alert them regarding a possible fall.

FORWARD THINKING/INNOVATION

The proposed smartphone- and Smartshoe-based gait analysis approach for fall prediction is innovative and state of the art because it provides a number of beneficial features together that current gait analysis approaches do not. The proposed design will be robust and reliable but, unlike current approaches, it does not require the wearing of sensors and does not require an infrastructure. Because this approach is implemented on a smartphone with low cost sensors integrated wearing shoes, it also gains the benefits of mobility and direct internet connectivity while being relatively inexpensive and non-invasive. Dr. Ahamed and Dr. Smith plans to evaluate the system for the real subjects who have chronic gait problem. Jahangir will use the information gained from this experiments to develop a novel real-time fall prevention system and will use in his dissertation study. Therefore this study will facilitate further research of the student and faculty.

STUDENT INVOLVEMENT

Jahangir is working on design and developing a smartphone-based gait biomechanical model of fall events for fall risk assessment by analyzing the gyroscope and accelerometer data from smartphone and data from the Smartshoe to predict the risk of falling. Using the system Jahangir will also assess the effects of balance abnormality on human walking patterns and the variability of the extracted features.

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PROJECT TITLE

Utilization of a SMS-Based Support System for American Indian Smoking Cessation

FACULTY

Dr. Sheikh Ahamed, PhD, Daniel Petereit, MD, Shalini Kanekar, MS, PhD (RCRH), Linda Burhansstipanov, MSPH, DrPH (NACI), Linda U. Krebs, PhD, RN, AOCN, FAAN (NACI), Mark Dignan, PhD (NACI)

STUDENT NAME

Drew Williams, Golam Mushih Tanimul Ahsan, Ivor Addo

INTRODUCTION

Despite the fact that use of tobacco results in over 30% of all cancer-related deaths in the United States [1], many tobacco users fail to cease smoking and improve their health. American Indian populations in particular often have a higher tobacco use rate, in part because of the religious connotations many tribes attribute to tobacco use. A recent study which surveyed several thousand Indian Health Service (IHS) patients showed a tobacco use rate of 3.6% in New Mexico, 13.2% in Minnesota, 23.5% in Oklahoma, 48.8% in South Dakota, and 51.5% in Wyoming, [2] with particular consistency regarding the South Dakota rate. [3-4] Studies also revealed that use often occurs by age 18, and is likely to lead to future dependence on nicotine. [5] As a result, a new method of smoking cessation, implementing the latest technology while remaining culturally sensitive, would be the best practice for assisting American Indians with smoking cessation. We have begun work developing this culturally-relevant smoking cessation program, based on the Theory of Planned Behavior and utilizing a phase-based framework to deliver a text-message based motivation system, breaking texts into a series of phases with the goal of motivating the user to cease their smoking habits. It is our hope that this approach will result in lower tobacco use rates amongst our participant sample, and result in a new method of smoking cessation to be used in American Indian populations.

SIGNIFICANCE

If our study proves successful, we will have implemented a technique for assisting American Indians with smoking cessation that not only is brand-new in approach, but remains relevant and sensitive to American Indian culture and religion. Especially since American Indians remain resistant to Western medicine, and thus smoking cessation medicine, in many cases, [6] this would be very helpful in helping American Indians realize the detrimental effects of smoking, and cease this activity. Furthermore, our text-message motivation system also could be extended to other age groups, cultures and problems, while remaining customizable and relevant to the population being helped. Utilizing SMS-capable cell phones over apps in particular would assist in this approach being accessible by many different populations, especially since access to wireless technology is rapidly increasing among Northern Plains American Indians.

FORWARD THINKING/INNOVATION

While there are many approaches that have been taken in coaxing smokers into stopping their habits of smoking, from talking with a counselor to various options in nicotine replacement therapy, none are like our proposed solution. However, our motivational text-messaging approach combines on-demand motivational messages, with a hefty degree of user customization (users can pick from several categories, and then sub-themes, when selecting which pool of messages they will randomly receive motivational thoughts from) and cultural relevance.

STUDENT INVOLVEMENT

Ivor, Tanim and Drew are working on developing the different components required by the system outlined above. Drew and Tanim are making a text server that sends individualized text messages to users with motivating words. Drew and Tanim's text server would also allow the on-demand access to human help in the event that a user requested it. Ivor is working on the server portion, and creating a method of storing and organizing texts by theme and category, allowing for precise user configurability.

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PROJECT TITLE: **Quantum Mechanical Description of Two Ions Trapped in the Double-Well Potential**

FACULTY NAME: **Dmitri Babikov**

STUDENT NAME: **Dmytro Shyshlov**

Chemistry Department, Marquette University, Milwaukee, WI, 53233, USA

In this computational work we study the system of two cold Be^+ ions trapped in the double-well potential and coupled by a long-range Coulomb interaction. The distance between ions is 40 μm. Ions are separated with the potential barrier of ~3 meV and frequencies of both ions are ~4 MHz. We carried out the exact quantum mechanical description of this system using accurate potential energy surface including all couplings (Fig. 1). In the vicinity of the global minimum we calculated the spectrum of vibrational eigenstates for this system. In order to quantify the effect of anharmonicity we computed coefficients of the 2D-Dunham expansion. Within this theory we can construct the initial vibrational wavepacket in one of the wells and observe its evolution over the potential energy surface. The purpose of this ongoing work is to explain vibrational energy transfer between the two wells, observed experimentally [1, 2].

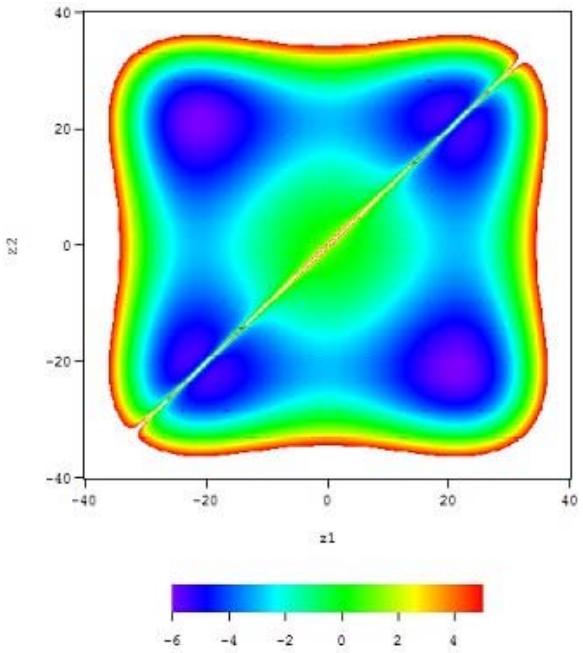

Fig. 1. Potential energy surface of two Be^+ ions in the trap.

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PROJECT TITLE: "A pilot study to develop a Cognitive intervention to support Dementia Caregivers: A Focus Group of Caregivers Caring for Persons with Dementia as Informants"

FACULTY NAME: Abir K. Bekhet, PhD, RN, H.S.M.I. Assistant Professor, Nursing
STUDENT NAME: Karie R. Kobiske, MSN, BSN, RN. Nursing Doctoral student

INTRODUCTION

The incidence and prevalence of dementia are on the rise. The most common form of dementia, Alzheimer's disease, is currently estimated to affect 1 out of 9 adults aged 65 and older in the US. [1] Eighty percent of the care provided for persons with dementia is provided by unpaid caregivers.[1] Previous research have shown that caring for persons with dementia can be very costly to caregivers' physical and psychological health[2]. Yet some caregivers of persons with dementia report that caregiving resulted in an enhanced sense of meaning in life and feelings of joy which resulted in decreased stress and positive mental health among dementia caregivers [3]. Dementia caregivers would benefit from cognitive-behavioral intervention that helps them to rise above their challenges and to be resilient. However, before delivering the intervention, there is a compelling need to identify Barriers and facilitating forces related to resilience from the dementia caregivers' perspectives. Resilience is a dynamic process including positive adaptation within the context of significant adversity in a manner that results in the identification, fortification, and enrichment of resilient qualities or protective factors [4]. Resilience will enable caregivers not only to survive the day to day burden associated with caregiving but to grow into a healthier and stronger person.

SIGNIFICANCE

Previous research have shown a positive outcomes for dementia caregivers who are resilient including coping effectiveness and health related quality of life [2, 3, 5]. However, the factors that enhance and or hinder resilience are lacking in the literature. Barriers and facilitating forces related to resilience need to be identified from the caregivers' perspectives before an effective cognitive intervention can be developed to promote resilience among dementia caregivers. The intent of this pilot study is to use a focus group of dementia caregivers as informants to identify factors that prevent and or facilitate resiliency. The aim of this study is to gather information from dementia caregivers that will be used to develop a full protocol for the cognitive behavior intervention that enhance resilience taking into consideration factors that prevent or facilitate resilience. The ultimate goal of this study is develop further studies that will serve to decrease the caregivers' burden and to enhance their psychological well-being.

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the challenges that dementia caregivers are facing that hinder and or facilitate their resiliency. Learning from caregivers' experiences will be helpful in building an intervention that has fidelity and can be tested in a prospective study. Dr. Bekhet plans to extend this study to test the cognitive intervention using the Positive Thinking Skills Scale that she developed recently during her Sabbatical Semester and was published in Western Journal of Nursing Research as a direct measure of intervention fidelity. IRB approval will be obtained once the proposal gets funded. Karie will use the information gained from this study to build on her PhD study as she is interested in music and resilience in dementia caregivers. Karie is currently a full time PhD student at Marquette. This study will facilitate further research of the student and faculty.

STUDENT INVOLVEMENT

Karie will take the lead on this project with the support of and collaboration with Dr. Bekhet. Ms. kobiske will recruit the focus group participants (n=10), develop the focus group questions, and lead the 2 hour focus group that will be tape recorded, transcribed and analyzed. Dr. Bekhet and Ms. kobiske will systematically code the data and analyze the themes, coming to mutual agreement in the process. Karie R. kobiske plans to study dementia caregivers and resilience for her dissertation. This study will open avenues and thoughts for her dissertation in terms of understanding the resilience concept and its barriers and facilitators. The information gained from this study will help her to develop a proposal that integrates some of the resilience enhancing factors and use them as intervening variables to help caregivers rise above their challenges and become resilient.

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PROJECT TITLE: Psychometrics of the Positive Thinking Skills Scale among Dementia Caregivers.
FACULTY NAME: Abir K. Bekhet, PhD, RN, H.S.M.I. Assistant Professor, Nursing
STUDENT NAME: Karie R. Kobiske, MSN, BSN, RN. Nursing Doctoral student & Matthew Greenwood, RN, TA

INTRODUCTION

One out of 9 adults aged 65 and older in the US are diagnosed with Alzheimer's disease; the most common form of dementia.[1] Eighty percent of the care provided for persons with dementia is provided by unpaid caregivers.[1] Dementia caregivers are at high risk for developing physical and psychological health problems and they experience a high rate of clinical depression as a result of the burden of caregiving. [2] A recent descriptive research has shown that positive thinking attenuated the effects of caregivers' burden and enhanced their levels of resourcefulness and psychological well-being in a sample of 80 caregivers of persons with dementia.[3] Therefore, Dementia caregivers would benefit from a positive thinking intervention that helps them to rise above their challenges and to be resilient.

SIGNIFICANCE

Previous research have shown that positive thinking is associated with better quality of life, less depression, greater life satisfaction, enhanced psychological and physical well-being, and a sense of meaning in life. [4] Therefore, dementia caregivers would benefit from a positive thinking training intervention. However, before delivering the intervention, a measure of intervention fidelity, that is, whether the intervention was implemented according to a planned protocol, is needed. The Positive Thinking Skills Scale (PTSS) [5] has been developed and published by the Principal Investigator but has not been tested in dementia caregivers. Therefore, the purpose of this study is to test the psychometric properties of the PTSS as a direct measure of intervention fidelity that is designed to capture the frequency of use of eight skills for thinking positively. The information gained from this study will be used to develop a full protocol for a cognitive intervention that has the potential to enhance caregivers' resilience. The fidelity of the intervention will be measured using the PTSS that will be tested in this study.

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the importance of testing the psychometric properties of the PTSS among dementia caregivers as a direct measure of intervention fidelity. This is an initial step toward implementing a cognitive intervention using the PTTS to measure the frequency of using the eight skills constituting the PTSS and to identify which of the positive thinking skills are used by caregivers, so these skills can be reinforced and the ones that are not used can be taught for better outcomes to dementia caregivers. Dr. Bekhet plans to extend this study to test the cognitive intervention using the Positive Thinking Skills Scale that will be psychometrically tested in this study as a direct measure of intervention fidelity. IRB approval will be obtained once the proposal gets funded. Matthew will use the information gained from this study to build on his master and PhD study as he is interested in positive thinking and mental health. Matthew is currently a teaching assistant for the mental health theory class that Dr. Bekhet is teaching. Also, he is working with her on a manuscript related to the concept of resilience. This study will facilitate further research of the student and faculty.

STUDENT INVOLVEMENT

Karie and Matthew will take the lead on this project with the support of and collaboration with Dr. Bekhet. Both will recruit the study participants (n=80), collect the data, and entering the data into SPSS. Dr. Bekhet, Mr. Greenwood, and Ms. kobiske will clean the data and analyze the results. Karie R. kobiske plans to study dementia caregivers and resilience for her dissertation. This study will open avenues and thoughts for her dissertation in terms of understanding the positive thinking as a protective factor for the resilience concept. The information gained from this study will help her to develop a proposal that integrates some of the resilience enhancing factors and use them as intervening variables to help caregivers rise above their challenges and become resilient. Matthew Greenwood is a direct entry student and a teacher assistant for my mental health class who has the passion for mental health and plan to use this information for his clinical practice and his master program to become a mental health practitioner.

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PROJECT TITLE: "**Sensorimotor Adaptation of Connected Speech Using Multiple Acoustic Cues"**
FACULTY NAME: **Jeffrey J. Berry, Ph.D., CCC-SLP, Assistant Professor, Speech Pathology & Audiology & Michael T. Johnson, Ph.D., Professor, Electrical & Computer Engineering**
STUDENT NAME: **Brittany Bernal, Undergraduate Student, Speech Pathology & Audiology**

INTRODUCTION

The broad objective of this line of research is to understand how auditory feedback manipulations may be used to elicit involuntary changes in speech articulation. We will further explore *speech sensorimotor adaptation*, to bolster the development of speech rehabilitation applications that benefit from this learning phenomenon. We believe the experimental methodology used in the proposed research could be further developed to help rehabilitate individuals with motor speech disorders who do not benefit from traditional, voluntary therapy techniques.

SIGNIFICANCE

Speech sensorimotor adaptation refers to experimentally elicited changes in a speaker's tongue, lips, and jaw movements induced by manipulations to the sounds a speaker hears himself producing[1]. Acoustic manipulations that affect auditory feeback elicit involuntary changes in a talker's speech movements. The altered patterns can be made to persist for some time, even after the signal modifications end, which suggests that speech can be re-learned[2]. The methods used in this line of research can be further developed to provide a novel form of speech neurorehabilitation. Two primary limitations in the current literature on speech sensorimotor adaptation are: 1) most studies have examined only sustained vowels or single words, not connected speech; and 2) few studies have examine how multiple, simultaneous acoustic manipulations may help facilitate articulatory changes. Our work will improve the ecological validity of this line of research by using more realistic speech acts and more realistic acoustic modifications.

FORWARD THINKING/INNOVATION

Previous studies of speech sensorimotor adaptation have examined simple speech acts, such as single spoken words using individual acoustic manipulations such as changes in vocal pitch. Our work will expand this research to study connected speech and the effects of multiple, simultaneous acoustic manipulations. Connected speech is representative of the speech that talkers typically use in daily life. We will institute multiple acoustic manipulations by integrating pitch changes with vowel-related changes in resonance. The specific relationship between vocal pitch and vowel-related resonance stems from the mechanical relationship between tongue position and the tension on the vocal cords. As talkers increase the height of their tongue position (changing resonance), the tension on the vocal cords increases (changing pitch). Thus, these studies will give more comprehensive and realistic conclusions about how auditory feedback effects may be used to alter articulation. We aim to determine if combining these acoustic features can increase the impact of auditory feedback manipulations on changes in articulation during connected speech.

STUDENT INVOLVEMENT

This work is a logical extension of work Ms. Bernal completed during the 2013 McNair's Scholars Program[3]. Ms. Bernal will be responsible for recruiting and screening participants for this experiment. She will help run experiments and analyze the obtained data. She will present the results of this work at a research conference and assist in the composition and submission of manuscript characterizing the work.

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PROJECT TITLE: "Articulatory space normalization investigation for EMA-MAE data set
FACULTY NAMES: Dr. Jeffrey Berry, SPPA, and Dr. Michael T. Johnson, EECE
STUDENT NAME: An Ji, PhD candidate and Xiangyu Zhou, master student, EECE

INTRODUCTION

SIGNIFICANCE

Human speech is generated through the movement of a complex set of articulators including the tongue, jaw and lips, controlled together through the speech production process. Articulatory information can be useful for speech synthesis, speech therapy, language acquisition, speech visualization and many other tasks. A bilingual multi-speaker acoustic-articulatory dataset, the Marquette Electromagnetic Articulography database of Mandarin-Accented English (EMA-MAE) has been collected under a recent project funded by the National Science Foundation. This is the first available 3-dimensional non-native speaker EMA dataset, and includes 20 speakers of American English (L1 subject group) and 20 speakers of Chinese (L2 subject group). These resources provide an opportunity to study pronunciation and articulatory variations across L1 and L2 groups. . A key challenge associated with cross speaker descriptions of articulatory postures relates to data representation. Speakers obviously differ in size and shape of articulators, and these differences may cause their articulatory behaviors to appear more different than they are. So a normalization approach is important and should precede an attempt to develop meaningful group descriptions, based upon data from multiple speakers.

Recently, normalization schemes have not been emphasized in speech kinematic studies, due to the limitation of kinematic data for a sufficient range of speakers. Several approaches have been proposed to address the normalization problem; however, no approaches to articulatory normalization have been proposed that are directly and easily applicable to this type of dataset. The goal of this study is to develop a simple normalization procedure that generates a speaker-general space within which descriptions of tendencies and variabilities of the phonemes postures are possible. The approach will be applied to our EMA-MAE data base to investigate the difference in pronunciation patterns between L1 and L2 speakers in terms of their articulatory configuration.

INNOVATION

There is no well-established normalization scheme for articulatory kinematic data. The methods which have been developed by different research groups attempt to create a normal representational space for individual subjects, and cannot be directly applied to our data base. Successful development of a robust normalization methodology will enable new methods for comparing complex articulator patterns and assessing first and second language speakers' pronunciation differences. The long-term goal of this work is to enable more comprehensive and effective feedback mechanisms in CALL (Computer Aided Language Learning) systems for pronunciation training.

STUDENT INVOLVEMENT

EECE PhD candidate An Ji and master student Xiangyu Zhou will take responsibility for this project with the support of Dr. Johnson. An's dissertation focuses on building a speaker independent acoustic to articulatory inversion model. This project is a good fit with her dissertation topic and will help her develop a more accurate articulator model across different group of speakers. Xiangyu's master thesis focuses on developing a mapping algorithm between measured articulatory coordinates and parameters for speech synthesis. This normalization project can help him develop a more consistent and accurate transformation mechanism.

PROJECT TITLE: Parameter mapping for articulatory speech synthesis

FACULTY NAMES: Dr. Jeffrey Berry, SPPA, and Dr. Michael T. Johnson, EECE

STUDENT NAME: Xiangyu Zhou, MS candidate, EECE

INTRODUCTION and SIGNIFICANCE

The RASS system is a clinical and research system that collects real-time movements of a subject's speech articulators (tongue, lips, and jaw) during speech and provides customized auditory feedback to the subject, eliciting an involuntary change in speech production. Such adaptive feedback mechanisms have the potential to be clinically useful for subjects with severe speech motor. In this modality, movement data is collected using an NDI (Northern Digital Incorporated) Electromagnetic Articulography (EMA) Wave system which registers the positions and orientations of small sensors attached to the tongue, lips, and jaw. The RASS system interfaces to the Wave system, calculates acoustic parameters of the sound, and then adjusts these parameters as directed by the experimenter and uses articulatory speech synthesis to generate auditory feedback. An important component of this system is the mapping of physical sensor movements to acoustic synthesis parameters, which is made difficult by a wide variance in subject physiology and articulatory working spaces. This research proposes to develop a new approach to mapping kinematic data onto synthesis parameters in a robust way that can be easily customized to individual subjects. The underlying goals of this research are to investigate and develop new methods for speech therapy in individuals with motor speech disorders.

INNOVATION

Although there are several methods for mapping articulator positions to a vocal tract model for speech synthesis, these require significant customization for each subject and thus are not directly suitable for our application. The method proposed here is a novel approach to automatically creating a mapping for each subject with minimal data and experimenter customization. To accomplish this we utilize the distance between the kinematic sensors and palate during the pronunciation of standard vowels to identify the relationship between sensor position and acoustic variables, and then transfer these acoustic variables to synthesis parameters.

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STUDENT INVOLVEMENT

EECE MS candidate Xiangyu Zhou will be responsible for this project with the support of Dr.'s Johnson and Berry.

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Project Title

"Influence of fluoride and stress on the mechanical and electrochemical properties of NiTi coils"

Faculty Name

David Berzins, Phd

Student Name

Ashley Barnes, DDS , Jennifer Roloff, DDS

Introduction

The major goal in Orthodontics is to use constant, light forces to efficiently move teeth into a physiologically and esthetically stable position. A variety of mechanics have been used throughout the lifetime of the specialty to accomplish these movements. One of the most innovative materials developed to institute these mechanics is nickel-titanium (NiTi). This material's superelastic characteristics allow for light, constant forces that are ideal for orthodontics. NiTi has been introduced into orthodontics in a variety of applications, most notably in the realm of arch wires and coil springs. Such NiTi coils can be used to open and close spaces between teeth, and will be the focus of our research.

Significance

NiTi coils are commonly used in orthodontic treatment. As clinicians, it is important to understand the nature and mechanics of this material, as well as any failures which may occur during treatment. The oral environment is dynamic by nature, constantly changing in pH and temperature as we go through our daily activites. Mastication, temperature change from food, and fluoride from dentifrice may have a significant affect on the mechanic properties and degredation of NiTi as it is applied in orthodontics. Without understanding the definitive actions this material has on orthodontic mechanics, orthodontists are left in the dark on how to provide true and efficient mechanical control of tooth movement when NiTi elements are involved.

Forward Thinking/Innovation

In this study design, the mechanical charactistics of NiTi coils will be tested under load, while being immersed in varying temperatures as well as a fluroride solution meant to mimic the conditions of the oral cavity. The results of this study will allow us to further understand the capabilities of NiTi coil springs, and provide orthodontists with the ability to make more evidence based treatment decisions in regards to their materials of choice and desired mechanics.

Student Involvement

The students will participate by assisting in the design of the proposed experment, as well as in running the experimental tests themselves.

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PROJECT TITLE**:** Better understanding of science and changes in self esteem and actions due to volunteering for citizen science

FACULTY NAMES(s): Jill Birren, Assistant Professor, EDPL
STUDENT(s) NAME: Gabrielle Belknap, Doctoral Student, EDPL

INTRODUCTION

Citizen science programs use volunteers, who may not have a professional science background, to collect large amounts of data for professional scientists. Current research in citizen science activities focuses on how citizen science contributes to professional science; there is little research on how participating in citizen science affects the participant's scientific knowledge, behaviors, and self-esteem. One of the largest US citizen science programs is housed at the Cornell University Ornithology lab, and these researchers attempted to analyze volunteers' understanding of the scientific method through unsolicited letters which volunteers sent to the researches about their bird counting experiences. Based on this experience, Cornell researchers realized that analyzing volunteers' scientific literacy is a daunting task (Trumbull, et al., 2000).

SIGNIFICANCE

We are seeking answers to the questions of how do volunteers change in their understanding of science, behaviors, and self esteem when they participate in citizen science activities. We have begun this research and will report preliminary analyses here. We worked with the Urban Ecology Center in Milwaukee to contact volunteers to be interviewed about their citizen science experiences. Some of these interviews have occurred, and we find that participating in citizen science can greatly impact volunteers' ecological knowledge and behaviors. Participants note that they are more aware of their science knowledge, have a higher sense of self esteem in terms of knowing science, and therefore are more willing to engage in scientific conversations as a result of participating in citizen science activities. Importantly, participants repeatedly note they change their behaviors and become more mindful in their actions because of their experiences with citizen science. These initial findings show that citizen science activities could be an effective way to teach science to improve public scientific literacy, and to encourage mindful use and protection of our natural resources.

FORWARD THINKING/INNOVATION

The study is innovative because it fills a gap in science education research by considering the learning outcomes of participating in citizen science work. Much of behavior research looks to how specific behaviors change as a reaction to directly related events. For example, if a person volunteers for a river walk activity, does he/she change habits to conserve water? What our research is finding is that people think and act more broadly after participating in citizen science research. Participants appear to change behaviors directly related to the volunteer activity, but more interestingly they are able to make behavior changes that reflect a more holistic way of thinking about their impacts on the natural world. We expect that further analysis will allow us to make this case more fully.

STUDENTS INVOLVEMENT

Gabrielle Belknap has been active in recruiting and interviewing volunteers; research and interview questions were formed as collaborative efforts between faculty and student. Analysis of data also continues to be a collaborative effort.

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PROJECT TITLE "The NoMo ratio in relation to upper lip length, age, gender, ethnicity and Angle's classification of malocclusion."
FACULTY NAME José Bosio, DDS, MS, Assistant Professor, Orthodontics
STUDENT NAME Audra Long, DDS, Orthodontics resident, 1st year

INTRODUCTION: The soft tissue paradigm has changed from dental and occlusal relationships centered to one that focused on facial proportions and the dentition's role in facial esthetics. Currently it states that "the goals and limitations of modern orthodontic and orthognathic treatment are determined by the soft tissues of the face, not by the teeth and bones" (1). Since the inception of the soft tissue paradigm into modern orthodontic practice, the research has focused on re-establishing the facial ideals or "canons" first proposed during the neoclassical period by Leonardo da Vinci and Albrecht Dürer (2,3). One major shortcoming of these canons is that they describe the facial proportions of Caucasians descent. A number of recent studies have challenged these ideals in facial esthetics and found significant differences between these proportions in modern Caucasian and non-Caucasian ethnic populations of different ages and genders (3,4). Our study aims to contribute to the current understanding of facial proportions by establishing and examining the nose to mouth (NoMo) ratio of study participants and determining correlations between this value, upper lip length, and patient identifiers such as age, gender, ethnicity and even Angle's classification of malocclusion.

SIGNIFICANCE: Should this ratio prove to have significant correlations with the length of the upper lip and/or patient age, gender ethnicity or Angle classification, it could serve as a key in establishing contemporary facial norms with potential diagnostic value. Further studies could examine whether this NoMo ratio changes as a result of orthodontic treatment.

FORWARD THINKING/INNOVATION: To the best of our knowledge, no research has yet examined the nose to mouth ratio and determined its significance in evaluating facial esthetics. We hope to contribute to the accumulating knowledge of normative facial proportions across diverse populations thereby increasing the accuracy and objectivity of orthodontic diagnosis and treatment planning.

STUDENT INVOLVEMENT: Audra Long (1st year resident, orthodontics) will participate in this project, serving as her thesis for completion of a Master's degree. She will maintain complete involvement in establishing the study's design, analyzing data, and writing the research paper including associated review of the literature.

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PROJECT TITLE: "A dynamic Bayesian approach to infer gene regulatory networks from multiple types of biological data"

FACULTY NAME: Serdar Bozdag, PhD, Assistant Professor, MSCS
STUDENT NAME: Brittany Baur, Computational Sciences Doctoral Student

INTRODUCTION

The invention of DNA microarrays, which can measure the mRNA expression of thousands of genes at a time, has been an important advance in molecular biology. One of the major goals has since been to infer a network of regulatory interactions between genes from the expression data. To this end, methods have been developed in different fields such as Bayesian statistics[1], information theory[2] and regression[3]. The dynamic Bayesian framework uses time-series expression data to identify relationships between genes based on conditional probabilities across time slices. It has been a historically popular approach because of its ability to handle noisy input data and avoid over-fitting of the data. More recent studies have attempted to integrate other sources of biological knowledge[1,3], such as promoter sequence motifs, literature, protein-protein interactions and DNA binding data. These studies have shown to greatly improve the inference. A small amount of studies have integrated epigenetic effects such as DNA methylation into various inference frameworks[3].

SIGNIFICANCE

Inferring gene regulatory networks is an important research area that helps characterize the biology of the organism in certain conditions. For instance, knowing the gene regulatory network in normal and tumor cells would help develop drugs to target certain genes that are potential "drivers" of the cancer. The aim of this study is to integrate multiple sources of biological datasets in the dynamic Bayesian framework to infer gene regulatory networks accurately. We plan to integrate mRNA expression, DNA methylation, copy number and several other biological datasets in our framework to increase the accuracy of the results. The integration of various datasets will help us recall existing interactions and avoid spurious ones.

FORWARD THINKING/INNOVATION

A novel approach will be used to integrate any type of biological data to infer edges in the network structure. Other studies have had limitations on the type and/or number of data types that could be integrated. Our meta-analysis framework will be flexible enough to allow any amount of data types to be integrated. Additionally, the different types of data can be weighted against each other. Higher weights can be given for data types that more strongly reflect biological relationships. To our knowledge, this is the first study that will incorporate DNA methylation and copy number into a dynamic Bayesian framework.

STUDENT INVOLVEMENT

Brittany Baur will have a lead role in conceptualizing, developing, and coding the algorithm under the supervision and support of Dr. Serdar Bozdag. The results from the inference algorithm will be analyzed by both Brittany Baur and Dr. Bozdag. The algorithm developed and results gathered in this study will be used towards Brittany Baur's dissertation.

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PROJECT TITLE: "Computing gene-centric DNA methylation from probe-level methylation arrays"

FACULTY NAME: Serdar Bozdag, PhD, Assistant Professor, MSCS
STUDENT NAME: Brittany Baur, Computational Sciences Doctoral Student

INTRODUCTION

DNA methylation is a biochemical process that adds a methyl group to cytosine nucleotides of DNA. It plays a key role in transcriptional silencing, and therefore is negatively correlated with gene expression. Recent advances in microarray technology have allowed measuring genome-wide methylation levels in DNA of higher-level organisms. In these microarrays, methylation levels of about 450,000 probes are measured, resulting in volumes of data. Each gene is associated with a number of probes. Thus, to compute the overall methylation level of a gene, one needs to analyze methylation levels of its probes.

In this study, we will develop a method to compute gene-centric methylation levels based on probe-level methylation data. We will also investigate regions where methylation may be more tightly correlated with gene expression. We will apply our method on different datasets to find out if the results are specific to each dataset or more universal.

SIGNIFICANCE

DNA methylation is an important epigenetic factor in cancer cells. Differences in DNA methylation in normal versus cancer samples has become an important area of research[1]. Computing gene-centric methylation levels is essential to be able to perform downstream functional analyses for these genes. It is also important to discover if there are common characteristics of probes that contribute highly to the methylation level of its gene.

FORWARD THINKING/INNOVATION

To convert probe-centric data to gene-centric, people choose only one probe for each gene, based on certain criteria such as probe location with respect to its gene, probe's correlation to the gene's expression level, etc. To the best of our knowledge, there is no study that uses a more comprehensive approach to compute gene-centric methylation data.

There has been some studies showing that methylation probes that are closer to the transcription start site of a gene has more correlation to the gene's overall expression[2]. Our study will be innovative to revisit this hypothesis computationally and check whether this hypothesis is gene- or disease-specific.

STUDENT INVOLVEMENT

Brittany Baur will have a role in developing and testing the algorithms to be studied under the supervision and support of Dr. Serdar Bozdag. Both Brittany Baur and Dr. Bozdag will conceptualize and develop various algorithms and methods for the project, as well as test the algorithms and analyze the results.

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PROJECT TITLE: Mechanical properties (Hardness Modulus) of commonly used clear aligner systems as-received and after clinical use

FACULTY NAME: T. Gerard Bradley, BDS, MS, Interim Associate Dean for Research and Graduate Studies
STUDENT NAME: Lauren Montoure Teske, DDS, 1st year Orthodontic Resident

INTRODUCTION

Patient demands for esthetic orthodontic treatment outcomes have grown to include esthetic appliances, such as ceramic brackets, lingual orthodontics and clear aligner therapy. The appearance of orthodontic appliances plays a significant role in patient's decisions to receive orthodontic treatment: a recent survey found that 33% of young adults would be unwilling to wear visible braces if needed (1). Another study found that while traditional metal brackets were found to be esthetically acceptable to only 55% of adults, clear aligners were acceptable to over 90% (2). Companies including Align Technology (Santa Clara, CA) and Allesee Orthodontic Appliances (Sturtevant, WI) have developed a method of fabricating custom-made, clear plastic aligners designed to gradually and sequentially move teeth to their desired positions using computer-assisted technology. The mechanical properties, structural conformation and leaching from three aligner systems will be assessed and compared in their as-received and in vitro aged states. The commonly used aligner systems that will be investigated include Invisalign (Align Technology), Simpli5 (Allesee Orthodontic Appliances), and Red White and Blue (Allesee Orthodontic Appliances). Approval from the Institutional Review Board (IRB) will be obtained. A representative sample of five trays will be taken from each patient. Additionally, a survey will be given to the patients using the aligners to assess overall satisfaction with them.

SIGNIFICANCE

Any significant difference in the hardness modulus of the aligners my have an impact on what aligner system the practitioner chooses to use, as a recent study found that thermoplastic materials with lower hardness show significantly lower orthodontic force on tooth movement (3). Additionally, studies have shown that Bisphenol A (BPA) can leach from plastics and epoxy resins in dental materials (4). Bisphenol A is a synthetic chemical resin used world wide in the production of plastic products, yet is a known endocrine disruptor. There is concern about the potential link between BPA and negative health effects, including abnormal sexual development, polycystic ovary syndrome, recurrent miscarriages, ADHD, autism, obesity, type II diabetes and an increase in hormonally mediated cancers, such as prostate and breast cancers (5). Any substance leached from the aligners will be characterized and we will identify if BPA is present in the samples.

FORWARD THINKING/INNOVATION

Mechanical properties, as well as the structural conformation and leaching have been previously studied on Invisalign (Align Technology) (6). However, Invisalign has recently changed the material they use in making their aligners to SmartTrack Aligner Material, which continues to be a polyurethane based material. Additionally, no studies to date have investigated the properties of other clear aligners such as Simpli5 (Allesee Orthodontic Appliances) and Red, White & Blue (Allesee Orthodontic Appliances). This research project will be the first to compare the mechanical properties of the three commonly used aligner systems and begin to look at the biological implications of using clear aligner therapy.

STUDENT INVOLVMENT

Lauren Montoure Teske (1st year orthodontic resident) will participate in this project, which will become her thesis leading to a Master's degree. She will be involved in gathering aligners, implementing experiments, analyzing data and writing the paper.

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PROJECT TITLE: Forecasting Natural Gas Demand for Electric Power Generation

FACULTY NAMES: Ronald Brown, George Corliss, and Richard Povinelli, Department of Electrical and Computer Engineering

STUDENT NAME: Paul Kaefer, Computational Sciences Master's Student

INTRODUCTION

Forecasting energy demand allows energy utilities to predict the load on their systems in the near future. This enables utilities to better plan their operations. Implications arise for plans that forecast lower or higher expected demand than the actual energy demand. For natural gas forecasting, these implications include the need to shut off customers when the forecast was too low to meet actual demand, or pay high storage costs, when the forecasted demand was higher than the actual. As a result, energy utilities have a high incentive to make accurate forecasts.

Historically, the most common use of natural gas has been heating[1]. This behavior has patterns that help in the development of forecasting models. Natural gas is increasingly being used to generate electricity, and is expected to continue to do so in the future[2]. As a result, natural gas utilities need to adapt their forecasting techniques to reflect the behavior of customers that use natural gas in power generation, since their use of natural gas is very different from the behavior of other users.

SIGNIFICANCE

Marquette University's GasDay Project works with about 30 natural gas distribution companies and delivers a software package that uses forecasting models to help these utilities predict natural gas demand. Utilities have several different types of customers with different behaviors that add to the complexity of the forecasting problem. Power generation customers are a class that behaves in different ways than other residential, commercial, or industrial customers.

FORWARD THINKING/INNOVATION

This research is innovative because forecasting how much natural gas will be used to generate electricity is a difficult problem that has not been widely studied. Since many energy utilities work in both the natural gas and electric power markets, this research could help expand the GasDay product offerings. GasDay supports a number of graduate and undergraduate students, and research like this enables the project to grow and continue to support students.

STUDENT INVOLVEMENT

Paul Kaefer, Graduate Research Assistant at Marquette University's GasDay lab, will take the lead on this project with the support of Drs. Brown, Corliss, and Povinelli, professors on the GasDay Project. Mr. Kaefer will review the current literature to gain a better understanding of all the factors involved in this problem. Mr. Kaefer will then develop models, with the collaboration of the aforementioned professors.

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PROJECT TITLE

USING EVOLUTIONARY PROGRAMMING TO INCREASE THE ACCURACY OF AN ENSEMBLE MODEL FOR ENERGY FORECASTING

FACULTY NAME

Dr. George Corliss

STUDENT NAME

Jim Gramz, MS

INTRODUCTION

There are multiple ways to combine different forecasts. Additional members can be added [1], the accuracy of current ensemble members can be increased through different variations of an Artificial Neural Network [2], or through a Bayesian approach with partial least squares, to name a few [3]. Currently, GasDay uses a partial least squares algorithm to track changes in the weather and gas usage to produce an accurate forecast for gas consumption. This implementation has been in use since 2008. Through work on evolution programming, we hope to be able to replace this ensembling technique with one that is able to determine specific variables for each part of the country to help gas companies forecast the natural gas usage of their customers.

SIGNIFICANCE

Every day, gas companies buy and sell natural gas on the open market similar to other commodities. If a Local Distribution Company does not have enough nature gas to meet its demands, it must either buy more, turn off certain interruptible customers, or pull some gas from their stored reserves. If a Local Distribution Company has more supply than is being demanded, they must either sell their excess supply, put it into storage, or pay a fine to the transportation company, since they did not allow the transportation company to sell the gas to another company and make a profit. Because of these requirements, an accurate forecast is important to make sure the correct amount of gas is bought and the savings is able to be passed on to the gas companies customers.

FORWARD THINKING/INNOVATION

Evolutionary programming is similar to genetic algorithms in that the structure of the program is fixed, while the parameter values are allowed to change. The concept of evolutionary programming has been around for decades and has been used to deduce previously patentable ideas. It has not been used for gas forecasting. The evolutionary program will use inputs of four current GasDay models along with other inputs deemed important for the forecasting of natural gas to generate an individual forecasting model for all 170+ op-areas served by GasDay to combine the inputs that are important for each individual area of the country.

STUDENT INVOLVEMENT

Jim Gramz, M.S. will take the lead on this project with the help and support of Dr. George Corliss. Jim will do the preliminary coding and integration with current GasDay code that is already in place. With the collaboration of Dr. Corliss, changes to the code will be made to increase the execution speed and the speed of convergence of the genetic algorithm. Changes will also be made to help the evolutionary program convergence by using domain knowledge to determine what the output template should look like and what inputs should be included. It will also leave values open for the evolutionary program to determine on its own.

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PROJECT TITLE: "Subtalar Joint Kinematics and Kinetics within Running Shoes during Ambulation using Biplane Fluoroscopy"

FACULTY NAME: Taly Gilat Schmidt, PhD, Assistant Professor, Biomedical Engineering
STUDENT NAME: Janelle Cross, MS, Biomedical Doctoral Student

INTRODUCTION

This study will be the first in the field to quantify three-dimensional foot joint motion and forces of subjects while walking with shoes on. Dynamic assessment of skeletal motion is necessary for understanding normal joint function, quantifying the effects of injury or disease[1], and for designing improved footwear and orthotics for a variety of orthopaedic disabilities. Conventional methods of motion analysis track skin-mounted optical markers with cameras to determine joint motion of the underlying bones[2]. However, conventional optical motion tracking systems cannot track motion while wearing shoes or orthoses, because the optical markers are obscured by the footwear. In addition, optical motion tracking methods have been found to suffer from error due to movement of the skin on which the markers are placed[2]. Fluoroscopy is a non-invasive imaging technique that obtains a sequence of x-ray images of a joint as it performs a dynamic motion. Biplane fluoroscopy has the potential to quantify six degrees of freedom joint motion with high accuracy and has important applications to a wide range of problems in orthopedics, sports medicine, and bioengineering[3]. Our research team has developed a biplane fluoroscopy system and is currently performing a normal subject trial to validate the methods. The specific aim of this project is to compare the motion and forces of the foot anatomy in normal subjects under two footwear conditions: barefoot and running shoes. The analysis will be performed using data acquired with our custom-built biplane fluoroscopy system on a walkway with an embedded force plate. The joint kinematics (motions) will be calculated from tracking the bone in the fluoroscopic images, while the kinetics (forces) will be calculated using the ground reaction forces from the force plate.

SIGNIFICANCE

Conventional motion tracking methods cannot visualize the motion of the foot when wearing shoes or foot orthotic devices. Fluoroscopy offers a valuable supplement to conventional motion analysis by obtaining dynamic measurements within shoes that are otherwise difficult to achieve. This study will be the first of its kind to track the bones of the foot and calculate three-dimensional joint motions and forces within shoes. This data will be valuable for designing and prescribing footwear modifications and custom orthotics for a variety of orthopaedic disorders. The athletic community is also interested in this data for improving performance and reducing injuries.

FORWARD THINKING/INNOVATION

While this study focuses on motion analysis during walking, successful completion of the proposed work will enable us to perform future studies to analyze motions of the bones within shoes while running. The biplane system will also allow for future studies involving pathological gait analysis, orthoses and shoe modification design for a variety of orthopedic disorders. The system will also enable the analysis of joint motion and forces of the foot during athletic movements, such as landing, cutting and pivoting, within different types of athletic shoe wear.

STUDENT INVOLVEMENT

Janelle Cross, M.S. has performed the preliminary work for this project, including developing the hardware and software methods. She will take the lead with the support and collaboration with Dr. Taly Schmidt to perform the analysis of the effects of running shoes on foot motion and forces. Ms. Cross will recruit the subject (n=15), perform initial screening for normal lower extremity function, and perform the motion analysis with the biplane system. This study will help her complete a portion of her dissertation work representing the translation of the developed technology to an important biomedical application.

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PROJECT TITLE: Biomechanical Modeling of Pediatric Clubfoot
FACULTY NAME: Gerald Harris, Ph.D., P.E.
STUDENT NAME: Tamara Cohen, B.S.

INTRODUCTION

Idiopathic clubfoot is a congenital deformity of the lower extremity affecting nearly 200,000 newborns each year worldwide [1]. This deformity presents with bone displacement and malformation, as well as alterations in the soft tissue [2]. Morphological studies have noted a fibrotic mass of tissue encapsulating the medial and posterior aspects of the foot [2-4]. The Ponseti Method is a conservative treatment that progressively repositions the clubfoot with weekly castings [4]. Although this treatment is widely accepted and successful, relapse of the deformity does occur. Untreated and under corrected clubfoot can result in abnormal gait, pain, and further deformity.

Relapse is dependent upon both treatment compliance as well as the nature of the clubfoot deformity [5]. It is hypothesized that the contractures of medial fibrotic mass tissue (MFMT) surrounding the foot may hinder correction. Previous studies have focused on histomorphological and immunohistochemical testing to investigate clubfoot soft tissue morphology and pathogenesis [3,4]. Few studies have investigated the mechanics of the MFMT or its effects on the success of treatment. Likewise, a quantification of the collagen fiber organization of this tissue and how it may relate to the tissue mechanics has yet to be assessed. The goals of this study are: 1) to model the structure and behavior of the medial fibrotic mass tissue in order to gain structural and functional insight, and 2) to employ this information to improve corrective approaches to long term clubfoot correction.

SIGNIFICANCE

Little is known about the material properties or mechanical behavior of the MFMT, thus longer term strategies for treatment of severe clubfoot are not based upon quantitative principles. Mechanical tests can provide information on the material properties and time-dependent (viscoelastic) behavior of the soft tissues as they respond to corrective treatment. To better understand the deformation of the MFMT during conservative (progressive casting) correction of clubfoot, its microstructure and mechanical behavior must be characterized. Information gained from this study will increase our understanding of clubfoot tissue response to load, which may lead to improved strategies for long term clubfoot correction.

FORWARD THINKING/INNOVATION

The proposed study is an investigation of tissue mechanics of clubfoot medial fibrotic mass tissue (MFMT). A low cost, uniaxial mechanical testing device for miniature soft tissue specimens has been designed and is being validated for application. This machine, comprised of a linear actuator, force transducer, custom grips, and video camera, is controlled by a custom-written protocol in LabVIEW. The MFMT, excised from patients undergoing routine clubfoot surgery (IRB approved), will undergo stress relaxation tests at different strains in order to quantify the elasticity of the tissue, as well as to model its material behavior over time. In addition, this tissue will undergo histological imaging in order to quantify the collagen fiber orientation and degree of organization. The relationship between the tissue mechanics and microstructure may provide yet another avenue for more effective correction through applied imaging technologies.

STUDENT INVOLVEMENT

Tamara Cohen will lead all aspects of this study as a major component of her dissertation. This includes design, validation, and testing of the soft tissue testing machine to be used for stress relaxation testing of the MFMT, mathematical modeling the tissue behavior based on test results, and characterization of clubfoot collagen fiber orientation using Image Pro Plus software. Tamara will contribute as the primary author under the direction of her mentor and dissertation committee in the publication of results in the peer reviewed, scientific and clinical literature.

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ABSTRACT

PROJECT TITLE: "Markerless Analysis of Upper Extremity Kinematics during Standardized Pediatric Functional Assessment with a Low-Cost Motion Analysis System"

FACULTY NAMES: Gerald F. Harris, PhD, PE & Susan A. Riedel, SM, PE

STUDENT NAME: Jacob R. Rammer, BS

INTRODUCTION

Hemiplegic cerebral palsy (HCP) is a disorder that presents in children as a motor impairment in the affected upper extremity (UE), resulting in reduced potential to perform activities of daily living. Therapists typically evaluate UE motion to gauge response to intervention using clinical evaluations or clinical motion analysis technologies, each having significant limitations. Many clinical evaluation protocols rely on subjective scoring by trained therapists [1], with a documented lack of sensitivity to detect change following interventions in the scoring of results [2]. Clinical motion analysis systems can precisely and reliably quantify UE motion in terms of angular kinematics, thus eliminating observer bias or subjectivity while increasing sensitivity in results, but require expensive equipment in a permanent laboratory setting and markers that are placed on the patient to detect motion [3]. The first generation Microsoft Kinect-based UE motion analysis system previously developed by the authors uses the low-cost video game accessory to determine the location of body segments [4], using algorithms developed to allow markerless skeletal tracking during standardized activity performance. The system has been pilot tested with normal adolescent subjects with favorable results and evaluated extensively to provide directions for future work.

SIGNIFICANCE

The Kinect system has many advantages over traditional motion analysis, including significantly lower cost, higher portability, and markerless operation, while maintaining reasonable accuracy. In order to enhance clinical evaluation in terms of therapist usability, patient enjoyment and motivation, and quality of results, the Kinect can be used to track and record body motion, thus including objective data in an otherwise subjectively scored evaluation. In this project, a comprehensive rehabilitation and clinical evaluation platform will be developed that includes a second-generation Kinect platform with enhanced kinematic tracking of UE motion and clinically actionable performance indicators. Focus will then shift to developing adaptive therapeutic games targeted to specific UE kinematic impairments in children with HCP based on input from clinicians, with an interface for activity selection, modification, and monitoring by therapists. Game selection and play by patients that permits home-based rehabilitation is also provided. In the future, the system will be expanded to address other populations of need, including adults with HCP, spinal cord injury, stroke, and other conditions. With the proposed system, therapists will have expanded flexibility to develop rehabilitation programs tailored to individual patients, with continuous feedback in performance metrics based on UE kinematics.

FORWARD THINKING/INNOVATION

The future development of this project is unique because the resulting system will improve kinematic reporting of a patient's condition when compared to typical clinical UE evaluations, and integrate therapeutic gaming, all in a system that is extremely low-cost, highly portable, and easy to operate. Patient enjoyment will significantly increase using this system through integrated gaming and elimination of both the repetitive nature of clinical rehabilitation and the difficulties of marker-applied clinical motion analysis. There is a need for a system that provides high-quality therapy and progress reporting at a low cost in the home environment.

STUDENT INVOLVEMENT

Jacob Rammer will lead technical development of the integrated Kinect therapy and evaluation system and organize the design of research studies to test the system with patients who have cerebral palsy. Support will continue from advisors Dr. Gerald Harris and Prof. Susan Riedel along with clinical collaborators.

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Project Title: Online Open Course Development for Healthcare IT Training

Faculty Participants: Thomas Kaczmarek

Student Participant: Inderpreet Kambo

Introduction

Electronic medical records can improve healthcare delivery [1]. Electronic medical records are the cornerstone of Healthcare Information Technology (IT). The Office of the National Coordinator (ONC) for Healthcare IT created a curriculum for training students to perform the tasks required to implement electronic medical records [2]. The ONC has made the curriculum elements available on a public website. Recorded lectures, lesson plans, and presentation materials are available, but these materials are incomplete for an online learning experience. To complete the picture we will use our experience and the guidelines and rubrics developed by Marquette University's Center for Teaching and Learning [3] to extend the available materials.

Significance

This project will provide the additional resources to enhance the curriculum and extend the opportunity to a broad international population in an English language format.

Forward Thinking/Innovation

This study recognizes the limitation of the currently available materials—they support for face-to-face courses. Potential local, national, and international students may not have access to a classroom situation to study the materials. Asynchronous online learning provides an option for these students. Important techniques used in asynchronous online learning include self-assessment and instructor facilitated discussion boards. If multiple students are studying the materials simultaneously (as in a MOOC [4]), discussion boards facilitate shared understanding. When no instructor is available to participate in the discussion board, the value may diminish, however, students could still benefit from shared observations in the discussion. This study will provide materials to investigate using shared discussions with and without instructor participation

Student Involvement

The Marquette University graduate student, Inderpreet Kambo, who is participating in the project is a healthcare professional (dentist) in his home country. He is familiar with healthcare and is studying healthcare technology management at Marquette University. He will develop the additional materials to support online asynchronous learning. The initial context for development is the Marquette University Desire 2 Learn e-learning platform.

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PROJECT TITLE: Probabilistic Sea-Level Rise Hazard Analysis
FACULTY NAME: Ting Lin, Ph.D., Assistant Professor, Structural Engineering and Structural Mechanics
STUDENT NAME: Matthew Thomas, M.S. Student, Structural Engineering and Structural Mechanics

INTRODUCTION

As the Intergovernmental Panel on Climate Change (IPCC) describes in their assessment reports, the effects of climate change on the natural environment are many, varying in scope and likelihood.[1] One of the most important and apparent effects of climate change is sea-level rise (SLR), resulting from ocean thermal expansion and melting ice sheets and glaciers. In their fourth and fifth assessment reports, the IPCC has suggested a number of different possible future greenhouse gas emission scenarios.[1] In addition, many models are available for the purpose of simulating the climate response to forcing factors such as greenhouse gas emissions.[2] The differences in these models often result in large discrepancies among themselves and with actual observations.[3] This study uses probabilistic hazard analysis to incorporate the aleatory and epistemic uncertainty of contributing models and parameters. Probabilistic hazard analysis is often performed in the civil engineering community to estimate structural reliability subjected to hazards such as earthquakes. [4]

SIGNIFICANCE

Significant uncertainties, both aleatory and epistemic, exist in SLR predictions. This project proposes a new analytical framework, termed Probabilistic Sea-Level Rise Hazard Analysis (PSLRHA), that accounts for aleatory uncertainties from IPCC emission scenarios and epistemic uncertainties from SLR prediction models. We can use the probability distributions for emission scenarios and SLR models to determine the likelihood of different levels of SLR occurring. In addition, Bayesian inference can be used to determine relative contribution of input parameters, such as emission levels, at a specified hazard level.[5] Similarly, individual model contributions can be determined. Ultimately, the data obtained would allow for the creation of a "Global Sea-Level Rise Hazard Map" (GSLRHM).

FORWARD THINKING/INNOVATION

This project innovates in the way that it combines various SLR and greenhouse gas emission models using probabilistic hazard analysis. To do this, the models first need to be regularized in terms of input parameters so that they can be considered simultaneously to provide the data needed for the creation of a GSLRHM. The GSLRHM itself would allow engineers and other decision makers in coastal areas to better evaluate the hazards caused by SLR, as well as facilitate multi-hazard analysis.

STUDENT INVOLVEMENT

Matthew Thomas will take the lead on this project with the support and collaboration with Dr. Ting Lin. Mr. Thomas' initial contributions will revolve around preparing the literature review for the study by researching different models available for predicting SLR as well as the contributing parameters and underlying uncertainty. He will also be involved in the process of visualizing the findings of the study, working to create the GSLRHM.

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PROJECT TITLE Effect of Mechanical Vibration on Osteoclast Formation Induced by LPS in Vitro
FACULTY NAME Dawei Liu DDS MS PhD, Associate Professor, School of Dentistry
STUDENT NAME Maxwell Abraham DDS, 1st Year Orthodontic Resident

INTRODUCTION Periodontitis is a common destructive disease damaging periodontal supportive tissues leading to loosened teeth, existing in 47-58% adults in the US (1). Pathologically, this bacteria induced inflammation disrupts the homeostatic balance of bone remodeling towards bone loss through excessive bone resorption by osteoclasts. Osteoclasts are derived from hematopoietic progenitors of the monocyte lineage through multiple steps. Receptor activator of NF-κB ligand (RANKL) and macrophage-colony stimulating factor (M-CSF) are essential for osteoclast formation (2). *Porphyromonas ginigvalis (P.gingivalis),* a gram-negative anaerobic bacterium and its cell wall product, lipopolysaccharide (LPS), is known to be a primary pathogen in periodontitis, resulting in recruitment of inflammatory cells, synthesis of cytokines and induction osteoclast formation and differentiation (3). Furthermore, studies have shown that *P.gingivalis* LPS accelerates RANKL signaling, causing more intensive osteoclast differentiation and cell survival, hence more pathological bone destruction. This level of evidence has been demonstrated with preosteoclastic cells (4, 5), bone marrow macrophages (6), as well as in an *ex vivo* tissue model (7). In orthopedics, low magnitude (0.3g) high frequency (30-45 Hz) mechanical vibration has been shown to have anabolic effects on osteoporotic patients (8). Recently, mechanical vibration has also been shown to be osteogenic to the alveolar bone in rats (9). More lately, a potential mechanism of the anabolic effect of mechanical vibration on bone remodeling has been revealed in Dr. Liu's lab (Marquette University School of Dentistry), in which mechanical vibration is found to be able to inhibit the RANKL induced osteoclast formation from osteoclast precursor RAW264.7 cells by down-regulating dendritic cell-specific transmembrane protein (DC-STAMP) (10). Overall, the current evidence leads us to put forward a hypothesis that mechanical vibration may have an inhibitory effect on osteoclastogenesis induced by *P. gingivalis* LPS. To test our hypothesis, we will apply mechanical vibration to osteoclast precursor RAW264.7 cells in the presence of *P. gingivalis* LPS to examine osteoclast formation, and explore possible mechanisms.

SIGNIFICANCE The effect of mechanical vibration on osteoclast formation induced by *P.gingivalis* LPS will be the direct evidence supporting us to apply mechanical vibration in the treatment of periodontitis. Completion of this project will not only add new knowledge of the effect of mechanical vibration on osteoclast formation induced by *P.gingivalis* LPS, but also lead to evidence-based clinical strategy of the mechanical vibration in treating periodontitis. In addition, the preliminary data to be obtained will allow us to apply for extramural funding from NIH.

FORWARD THINKING To the best of our knowledge, we are the first to explore the effect of mechanical vibration on osteoclast formation from osteoclast precursor cells induced by *P.gingivalis* LPS. If our hypothesis is proven, mechanical vibration will promisingly become an affordable, non-invasive, non-pharmaceutical adjunctive treatment for periodontitis.

STUDENT INVOLVEMENT Maxwell Abraham (1st year orthodontic resident) will participate in this project, which will become his thesis leading to a Master's degree. He will be completely involved in designing and implementing experiments, analyzing data and writing research paper.

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Proposal for Forward Thinking Poster Session At Marquette University (Dec. 3, 2013)

1. **Project Title**: Development of an Aquaponics Research Program

2. **Faculty**: Richard Marklin, Margaret Mathison, Brooke Mayer, Mark Nagurka, Vikram Cariapa, Michael Schlappi

3. **Students**: James Deane, COE UG, COE graduate student(s) TBN

4. **Introduction**: Aquaponics is a closed-loop, recirculating fresh water system in which plants and fish grow together. Fish and vegetative plants can be grown 24/7 every day of the year with an aquaponics system, which uses liquid fish waste (ammonia from fish gills converted to nitrates) as food for plants, which in turn clean the water for the fish. No soil is used in an aquaponics system. R. Marklin has recruited a team of 6 Marquette U. faculty in various disciplines to conduct aquaponics research. The research void is the economic feasibility of aquaponics in a cold climate (Great Lakes region). Specifically, we will quantify with high precision the *relationship between the amount of capital and operating costs (construction, labor, energy, fish food, and supplies) to the output (weight of fish and organic greens) of a small aquaponics system (6 x12').*

5. **Significance:** This proposed project addresses specifically the limited 4 to 5 month soil-based growing season in the Upper Midwest Lakes region for production of locally grown, fresh food (protein and vegetables) and the supply of fresh water for agriculture. An efficient, small-scale aquaponics model would allow homeowners and small businesses to produce their own fish and vegetables 24/7 every day of the year *with minimal amount of fresh water,* providing high quality organic greens and fish protein to diets. As the use of home and small business aquaponics units increases, there would be less need to import vegetables and fish protein from California, Florida, and offshore (such as South America, Vietnam, and Indonesia) to the Upper Midwest, which would decrease greenhouse gas emissions due to fossil fuel-dependent transportation systems.

6. **Forward Thinking**: The project addresses the critical issues of fresh water use and urban unemployment. If aquaponics systems were economically feasible, then urban residents would be able to grow high quality fish protein and vegetables above the ground (above polluted soil) and provide food and jobs for local urban communities.

7. **Student Involvement:** James Deane, COE UG student, worked as a research intern on the project in Summer 2013. Graduate students would be hired as extramural funding is procured. In Spring 2014 COE students will help build the greenhouse, which the MU Office of Architect has approved. Construction costs will be approximately $5000, and the estimated total cost of electricity will be less than $500 per year.

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PROJECT TITLE: "Removal of Environmental Estrogenic Micropollutants from Wastewater Solids"

FACULTY NAME: (PI) Patrick McNamara, PhD, Assistant Professor, Environmental Engineering
(Co-PI) Daniel Zitomer, PhD, Professor, Environmental Engineering
STUDENT NAME: Thomas Hoffman, Environmental Engineering Master's Student

INTRODUCTION

Handling and disposal of wastewater biosolids has become an expensive undertaking for wastewater treatment plants (WWTPs). For processes such as land application, the content of the solids is under scrutiny because whatever is in the solids can transfer to the environment and be harmful for plants and animals. Such chemicals of concern include endocrine disrupting chemicals (EDCs), which interfere with the hormone system in mammals and can lead to such effects as feminization of fish populations (*1*). These micropollutants are sometimes estrogenic and can come from personal care products, such as hand soap and deodorant containing antimicrobial agents, contraceptives, and other medications. They are flushed down house drains and can pass through wastewater treatment processes and remain in the biosolids. Currently, some WWTPs are processing the solids coming from anaerobic digestion, a wastewater treatment process utilized to produce less solids and energy in the form of methane, into a soil amendment used as a fertilizer. This soil amendment may provide a pathway for these micropollutants to the environment and eventually lead to human exposure. Pyrolysis, the partial decomposition of organic material in an oxygen-deprived system under high temperatures, is a possible solution for removing estrogenic compounds from these solids.

SIGNIFICANCE

The goal of this research is to track estrogenic compounds through the wastewater treatment process and evaluate pyrolysis as an effective amendment to the typical treatment process. The YES assay will be used to determine the relative estrogenicity of solids samples through a wastewater treatment plant, and through a post-treatment pyrolysis process. Biochar from bench scale pyrolysis tests at different temperatures will be evaluated since increasing the final temperature of sewage sludge has been shown to decrease the solids fraction and increase the gas fraction while the liquid fraction remains constant (*2*). This research will facilitate further investigation into biochar as a less hazardous soil amendment.

FORWARD THINKING/INNOVATION

Currently measures are not being taken to remove EDCs from biosolids. Pyrolysis can be a sustainable option to remove these estrogens while reducing the solids volume to a beneficial soil amendment. This process has the possibility to have minimal or no net energy loss after the production of the syngas and oil. Dr. McNamara plans to use these experiments to move forward in micropollutant research for wastewater treatment. Showing that pyrolysis added into a typical treatment plant can be sustainable and reduce harmful environmental impacts can accelerate the possibility of full scale implementation.

STUDENT INVOLVEMENT

Thomas Hoffman will design and perform experiments related with this project under the guidance of Dr. Patrick McNamara. Experiments include utilizing the YES assay and a bench scale pyrolysis reactor in the Water Quality Center.

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PROJECT TITLE: "Fate of Micropollutants During Pyrolysis of Biosolids"
FACULTY NAME: Patrick McNamara, PhD, Professor, Environmental Engineering;
Daniel Zitomer, PhD, PE, BCEE, Professor, Environmental Engineering
STUDENT NAME: John Ross, Engineering Masters Student

INTRODUCTION

Urban wastewater treatment plants collect, treat, and discharge both domestic and industrial wastewater. An emerging class of contaminates have been detected in this wastewater from industrial, household, and pharmaceutical and personal care products (e.g. prescription drugs, plasticizers, and pesticides). Many of these compounds were designed to be recalcitrant and are therefore not fully removed in conventional wastewater treatment processes. Concern exists over these micropollutants due to their demonstrated ability to harm or alter aquatic life and spread antibiotic resistance (Schwarzenbach et al. 2006). In the wastewater treatment process, a key step is to separate out solids from the wastewater. The most common way to beneficially reuse these solids, called "biosolids," is to apply them to agricultural land due to their ability to deposit nutrients and organic carbon into the soil. Analysis of biosolids samples has shown that biosolids regularly contain the micropolluants described above. In the United States alone over 200 metric tons of micropollutants are discharged to the environment with biosolids each year (McClellan & Halden, 2010), and Denmark has already banned land application of biosolids containing moderate levels of micropollutants (Danish Ministerial Order, 1996). This potentially limits the beneficial reuse of biosolids as a land amendment product in the United States due to concern for the introduction of micropollutants to agricultural soils and runoff.

SIGNIFICANCE

The goal of this research is to assess the pyrolysis of wastewater biosolids for the resulting fate of micropollutants. Pyrolysis is the thermochemical decomposition of organic matter in an oxygen free environment in an elevated temperature range. Pyrolysis of biosolids produces a combustible gas and oil that can be used for renewable energy and a solid product called biochar. Biochar was demonstrated in the Marquette Water Quality Center to adsorb nutrients from wastewater and increase crop yields when used as a land amendment product. The study will be designed so that a mass balance of micropollutants can be conducted following pyrolysis by assessing the gas, oil, and biochar products for micropollutant concentrations. It is hypothesized that micropollutants will be thermally removed from the solid product and have the potential to partially or fully degrade. Additionally, biochar will be assessed for use as an absorbent material to remove micropollutants from wastewater.

FORWARD THINKING/INNOVATION

There has been a shift within the wastewater treatment industry to re-envision the wastewater treatment process as an opportunity to recover and reuse valuable nutrients, energy, and water. As mentioned, current disposal methods for wastewater biosolids often carry environmental concerns and are generally fossil fuel intensive. Efforts are being made to holistically assess biosolids management plans using environmental, economic, and social elements. An overarching goal that has been identified to optimize sludge management programs is to reduce the amount of sludge disposed and potential environmental impacts with a given reuse option. Pyrolysis is a major technology that is being evaluated to further these forward thinking efforts. The pyrolysis of biosolids produces both renewable energy, reduces the solid product produced, and, if the test results confirm micropollutant removal from biosolids, a more environmentally benign land amendment product in biochar.

STUDENT INVOLVEMENT

John Ross will design and execute experiments associated with this project under the guidance and collaboration of Dr. Patrick McNamara and Dr. Daniel Zitomer. Master's students and undergraduates in civil and environmental engineering will assist with experimental setup, monitoring, and data collection.

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PROJECT TITLE: "Modeling the cleanability of reusable medical devices: regulatory and manufacturing perspectives"

FACULTY NAME: Stephen J. Merrill, PhD, Professor, Mathematics, Statistics and Computer Science
Victoria M. Hitchens, PhD, Food and Drug Administration, CDRH/OSEL/Division of Biology
STUDENT NAME: Casey J. O'Brien, MS, Computational Sciences Graduate Student

INTRODUCTION

In 2009, a hospital in Texas experienced an outbreak of *Pseudomonas aeruginosa* bacterial infections in patients who had knee or shoulder surgery, which were traced back to contaminated surgical instruments[1]. Specifically, arthroscopic shavers were found to have collected tissue despite reprocessing procedures. Reusable medical devices, such as arthroscopic shavers, must undergo a thorough cleaning process before sterilization. The presence of remaining tissue and bone fragments, often obscured from visual inspection as a consequence of design, can allow microbiological organisms to survive sterilization. In addition to releasing several statements regarding the safety of arthroscopic shavers, the FDA (Food and Drug Administration) has been reviewing their guidelines on the reprocessing of reusable medical devices[2]. While doing so, FDA has acknowledged that the design of these devices greatly influences their ability to be cleaned in practice. Aspects of the geometry of modern devices, such as long narrow lumens, sharp corners, and inaccessible components, make reprocessing especially challenging.

SIGNIFICANCE

Mathematical modeling has begun to play a more substantial role in informing the regulatory process. The goal of this project is to develop a model for the use and reprocessing of reusable medical devices. Given a description of a medical device, we would like to be able to answer the question, to what extent can this device be cleaned? From a manufacturer's point of view, a model such as this could guide the design process and ultimately lead to the development of better devices. Through better design and cleaning instructions, we can hopefully reduce the number of infections from reusable medical devices.

FORWARD THINKING/INNOVATION

Applied judiciously, models have the potential to play a powerful role in the regulatory process. This project provides a unique opportunity not only to develop a useful tool that can become part of the workflow at FDA but also to advance the understanding of the use of models in the context of regulatory science. We hope that our work complements that of FDA researchers who are charged with evaluating current reprocessing protocols and developing best practices for the design and documentation of reusable medical devices.

STUDENT INVOLVEMENT

Casey O'Brien will develop the model under the supervision of Dr. Stephen Merrill, currently a Visiting Professor at FDA and Victoria Hitchens, Head of Infection Control Laboratory at FDA/CDRH/OSEL/Division of Biology. FDA will be providing materials and direction. Work will begin with considering a series of acrylic lumens with varying geometries. Data collected by researchers at FDA on the accumulation of biological material from clinically relevant test soils will inform the development of an initial model.

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PROJECT TITLE: "A pilot study investigating the role of executive functions in the language and literacy achievement of young, low-income English Language Learners"

FACULTY NAME: Maura Moyle, PhD, CCC-SLP, Associate Professor, Speech-Language Pathology
STUDENT NAME: Jodi Schmitz, BA, Speech-Language Pathology Graduate Student

INTRODUCTION

The population of the U.S. is becoming increasingly diverse. It is estimated that one in ten school children speaks a language other than English at home. Often, school entry is the first exposure to English for children from linguistically diverse backgrounds. As a result, these children, referred to as English Language Learners (ELLs), have a challenging task ahead of them: learning academic skills, such as reading and math, while also learning a new language. Although many children navigate this challenge successfully, others are not so fortunate. For example, in Milwaukee Public Schools the achievement gap in reading for 10th grade ELLs is 26%. In Wisconsin, the high school graduation rate for Hispanic students, most of whom are ELLs, is 74%, compared to 92% for White students. An additional confounding factor is that a large proportion of ELLs come from low-income families. Children from lower socio-economic status (SES) homes are at-risk for academic underachievement (Hagans & Good, 2013).

Research has found that executive functions (EFs) are critical to academic success. In fact, EFs are more important for school readiness than IQ, and EF skills continue to predict reading and math achievement throughout the school years (Diamond & Lee, 2011). Executive functioning refers to the brain's ability to make decisions and carry them out, such as during intentional problem solving. Research on school-age bilingual children has shown that they have superior EF skills compared to monolinguals (e.g., Bialystok, 2011). If enhanced EF skills are the result of bilingualism, perhaps they could also play a role in facilitating language and literacy development in young children. Recent pilot data collected from low-income African American preschool children who spoke African American English showed that performance on the Dimensional Change Card Sort Test, a measure of EF, was significantly correlated with their early literacy skills (i.e., phonological awareness and print knowledge).

SIGNIFICANCE

Given the increasingly diverse population of the U.S., innovative educational approaches need to be developed and assessed, particularly for children who are low-income ELLs. Recent research has shown that EFs can be improved in children through various approaches resulting in improved academic performance and self-regulation (e.g., Flook et al., 2010); however, no studies have focused on the benefits of EF interventions for low-income ELLs. Many of the approaches shown to be effective in improving EFs are relatively language-free (e.g., visual-spatial skills, meditation, yoga) and therefore may be appropriate for students with low English proficiency. The aim of this pilot study is to gather data on the relationships between language, literacy and EF skills in young Hispanic/Latino ELLs. We predict that children with better language and literacy skills will have superior EF skills. These data will be included in an NIH grant proposal investigating the effectiveness of interventions targeting EF skills in young low-income ELLs, and measuring positive effects of EF interventions on academic achievement.

FORWARD THINKING/INNOVATION

Increasing attention is being paid to the relationship between EF skills and academic functioning in children; however, no research has focused on ELLs. The long-term goal of this research is to investigate an innovative educational approach for facilitating academic achievement in ELLs by focusing on development of their EF skills and examining the potential benefits to their language and literacy acquisition.

STUDENT INVOLVEMENT

Jodi Schmitz, BA will collect data, assist in data processing and analysis, and co-author a conference presentation with Dr. Moyle based on the results.

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PROJECT TITLE: "Parallel Slice Multiband Aliasing of Multiple Slices and Separation of Multiple Complex-Valued Images"

FACULTY NAME: Andrew S. Nencka, PhD, Associate Professor at Medical College of Wisonsin, Biophysics
Daniel B. Rowe, PhD, Associate Professor at Marquette University, MSCS
STUDENT NAME: William D. Castedo, BS, MSCS Doctoral Student

INTRODUCTION:

In functional magnetic resonance imaging (fMRI), each slice in a volume is individually excited, measuring enough data in a single k-space array to reconstruct an image for that slice. Over the last decade, techniques have been developed to sample less data within an image thus decreasing the acquisition time for an image of each slice. However, a new thrust is to simultaneously excite multiple slices that make up a volume and sample sufficient data in a single k-space array to represent multiple slices. This single array of k-space data can be reconstructed into a single image representing the aliased slices, and then separated into individual images for each slice. A technique and statistical description has been presented for aliasing and separating two complex-valued slices with a single coil image. The thrust of this work is to extend that work to separate complex-valued images for a higher numbers of aliased slices and present statistical implications. In fMRI, an image volume is generally made up of slices of images.

SIGNIFICANCE:

The cognitively functioning brain changes rapidly and a volume of image slices takes on the order of a second when complete image spatial frequency data is measured. Since parallel imaging was conceived (1), methods such as SENSE (2) and GRAPPA (3) or their variants have greatly contributed to the in-plane acceleration of images using multicoil arrays to subsample spatial frequency lines and reconstruct an image of a single slice. Recent research efforts have been focused on the simultaneous excitation and acquisition of multiple parallel images of slices to build up a single volume. Initial work on the topic involved the acquisition of images of two simultaneously excited slices in two experiments with a single channel coil (4, 5), which was extended to multiple slices using multiple channel coils in a single experiment (6, 7), and to two encoded slices using a single channel quadrature coil (7, 8, 9). Here a new complex-valued approach for acquiring a single complex-valued image of multiple slices and separating multiple complex-valued images of slices using a multiple channel coil array is described. The recent line of research for increased biological information utilizing complex-valued images and magnitude-phase time series models to compute fMRI activation (10) provides the motivation to separate complex-valued images.

FORWARD THINKING/INNOVATION:

This project is groundbreaking because it would drastically decrease the acquisition time between each temporal resolution, thus allowing a better picture of brain connectivity. Dr. Rowe plans to extend this project to observations of eight coils acquiring sixteen slices. The goal of this is to facilitate further research of separation of parallel images to increase volume speed in fMRI. Ultimately, this project could lead to a solid foundation and start for a thesis and peer-reviewed publication.

STUDENT INVOLVEMENT:

William Castedo will explorer and further develop the Matlab code for unaliasing multiple packages of multiple coils in parallel images. He will also further investigate the statistical properties of this image separation method, specifically mean and correlation values, over multiple acceleration factors and various package configurations.

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PROJECT TITLE: "Utilizing a Temporal Frequency Representation of the Spatial Correlation Matrix to Measure the Impact of Processing on Spectral Content"

FACULTY NAME: Daniel Rowe, PhD, Associate Professor,
Department of Mathematics, Statistics, and Computer Science
STUDENT NAME: Mary Kociuba, Computational Sciences Doctoral Student

INTRODUCTION

The human brain is one of the most complicated systems in the universe, which is exactly what makes it one of the most exciting scientific frontiers. FMRI allows us to observe brain activity with increased neural activity reflected as a change in regional blood oxygenation level dependent (BOLD) fluctuations[1]. It is well-known that specific regions of the brain are functionally connected. Spatial and temporal correlations observed from physiological BOLD fluctuations within the brain during task activation have similar patterns as those observed from low frequency resting state fluctuations. Thus, resting state functional connectivity is related to task activated spatiotemporal correlations[2]. Accurately representing spatial correlations of biological origin during resting state provides a basis to compare diseased and healthy brains. However, spatial correlations, of no biological origin, are induced as a result of image processing and reconstruction[3,4]. Thus, there is difficulty distinguishing the true biological spatial correlations and the artificially induced spatial correlations in reconstructed neural images.

SIGNIFICANCE

In this study, the exact theoretical spatial covariance and correlation matrices are derived, such that the spatial correlation between voxels is represented as a linear combination of second order voxel temporal frequencies. This representation of the spatial correlation matrix provides the foundation to quantitatively determine the effect of commonly applied processing operations on the structure of the spatial correlation matrix in terms of the impact on the voxel temporal frequency spectrum. Additionally, representing these statistical relationships in terms of temporal frequencies provides a framework for identifying the frequency bands that contribute substantially to the induced correlations. Accurately modeling the impact of spatiotemporal processing operators is the first step to accounting for artificially induced spatial correlations, such that the true connectivity in the brain is correctly represented. Understanding where true biological spatial correlations exist is critical to developing noninvasive methods to identify the onset of neurological disorders or tracking the progression of degenerative brain diseases.

FORWARD THINKING/INNOVATION

This study is innovative because it aims to identify the true biological spatiotemporal correlations, and understanding where artificially induced correlations exist within the temporal frequency spectrums facilitates the understanding of progression of neurological diseases through a noninvasive means. The results and conclusions from this study will be included in Mary Kociuba's dissertation, and will provide a foundation for further research in the area among other students and faculty.

STUDENT INVOLVEMENT

Mary Kociuba will take the lead on this project with support and collaboration with Dr. Daniel Rowe. The results and conclusions from this study will be the first chapter of Mary Kociuba's dissertation with the expectation that it will be submitted for publication, and will provide a foundation for further research in functional connectivity MRI to be included in her dissertation.

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PROJECT TITLE: Brain activation from sensory feedback during pedaling in people post-stroke
FACULTY NAME: Sheila Schindler-Ivens, P.T., Ph.D., Assistant Professor, Physical Therapy
STUDENT NAME: Brice Cleland, M.S., CTRH Doctoral Student

INTRODUCTION

Stroke is highly pervasive in the United States, affecting 6.8 million individuals with nearly 800,000 new strokes each year[1]. The estimated yearly health cost associated with stroke in the United States is $38 billion[1]. After having a stroke, individuals often experience hemiparesis, or one-sided muscle weakness, which can lead to difficulty with locomotion. In people with stroke, several studies have used functional magnetic resonance imaging (fMRI) to describe what areas and to what extent the brain is active during movement tasks. Using voluntary pedaling as a surrogate for locomotion, people with stroke had a reduced volume of brain activity compared to healthy control subjects[2]. Although finding reductions in brain activity during voluntary pedaling is compelling, it is unclear what leads to these changes. One explanation for this reduction is that people with stroke are performing the task differently; namely, the unaffected leg is contributing nearly all the muscle activity necessary to continuously pedal, with little contribution from the affected leg. This study aims to control for these task differences by having the investigator rotate the pedals for the relaxed subjects (passive pedaling). When this is performed in healthy controls, the brain activity is nearly identical to when the subject is voluntarily pedaling[3]. If differences in task performance are affecting brain activity in people with stroke, then we expect to see a similar level of brain activity as compared with control subjects during passive pedaling.

SIGNIFICANCE

Based on previous research, it is unclear what may be leading to a reduction in brain activity during voluntary pedaling in people with stroke. The results from this study will help clarify what mechanisms may be causing the observed reduction in brain activity post-stroke and guide future research. Specifically, these results will allow our laboratory to identify whether the difference in brain activation is likely the result of behavioral differences, changes in excitability of the brain, sensory processing, or changes in the brain arising from active movement. If the active and passive conditions lead to similar levels of brain activity, then passive movements could be pursued as a potential rehabilitation tool in the early stages post-stroke.

FORWARD THINKING/INNOVATION

This study is innovative for several reasons. First it uses pedaling as a novel method for investigating locomotion while obtaining fMRI data. fMRI requires the subject to be lying on their back with their head still, so walking cannot be performed under these conditions. Pedaling provides an approximation of the reciprocal and cyclical muscle activation seen during walking, and it can be used in the scanning environment. A second innovation of this study is that it is attempting to address the source of changes in brain activation. Most studies that have explored movement after stroke have not investigated whether changes in brain activity were the result of behavioral differences or changes in the physiology of the brain. Both of these innovations will lead to a better understanding of changes that occur post-stroke and potentially lead to rehabilitation strategies using passive movements.

STUDENT INVOLVEMENT

Brice Cleland is a Ph.D. student working under Dr. Sheila Schindler-Ivens in the Clinical and Translational Rehabilitation Health Science program. He will lead the project as part of his dissertation with the support of Dr. Sheila Schindler-Ivens. Mr. Cleland will be in charge of reviewing the relevant literature, designing the protocol, performing the experiments, analyzing the data, and writing up the results. Dr. Schindler-Ivens will be in charge of subject recruitment and will provide guidance throughout all phases of the project.

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PROJECT TITLE: "Locally Robust Regional Eigenvalue Assignment State-Feedback Controller Design for Circular Regions via LMI Techniques"

FACULTY NAMES: Susan Schneider and Edwin Yaz, Electrical and Computer Engineering
STUDENT NAME: W. Alexander Baker Jr., Electrical and Computer Engineering

INTRODUCTION

Regional eigenvalue assignment techniques have been used to place the eigenvalues of a linear system within well-defined regions of the complex plane. Generally, the shapes of those regions can vary, from circles to cones to vertical strips. This design method is in contrast to well-known standard methods which place the poles at exact points on the complex plane. Circular regional eigenvalue assignment is done by applying the discrete-time Lyapunov stability criteria to the open-loop system using linear matrix inequalities (LMIs) [1]. Theoretically, the size of the region will allow for a degree of robustness proportional to the radius of the circle.

SIGNIFICANCE

This research seeks to use LMI techniques to design circular regional eigenvalue assignment state-feedback controllers for nonlinear systems with norm-bounded nonlinearities and to quantify the performance robustness of the closed loop systems. Based on the size of the circular region specified, a quantifiable degree of robustness should be guaranteed if the LMI is feasible. This degree of robustness is theoretically proportional to the maximum bound on the nonlinearity.

FORWARD THINKING / INNOVATION

The use of the locally robust feedback controller will allow the designers to design their controllers around a defined region in the complex plane which has the desired stability and transient response properties established by the designer. The design process yields both the necessary feedback gain matrix and the value of the maximum slope of system nonlinearity the closed loop system can accommodate while still maintaining its desired performance. The design technique is suitable for use to design controllers for both discrete-time and continuous time systems and should be easily extendible to the design of dynamic state-feedback controllers for systems where some or all of the states are unknown.

The results of the preliminary research, using linear systems with external additive disturbances, show that certain robustness properties of the controller and observer are guaranteed [2]. Preliminary results also demonstrate a localized monotonic increase in the bound on the parametric perturbations as the radius of the circle increases. These properties will allow for the design of locally robust controllers for certain classes of nonlinear systems using the LMI technique.

STUDENT INVOLVEMENT

The graduate student will carry out the research to define and quantify the performance robustness of the region specified in the proposed locally robust feedback controller design. He will validate the proposed technique via simulation of robust control design for several nonlinear benchmark control systems (e.g., mass-spring-damper, inverted pendulum). He will obtain the maximum bound on the nonlinearity and test the performance of the closed-loop nonlinear system against the nominal closed loop response of the linear component.

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PROJECT TITLE

Using Optimal Control Techniques for Regional Eigenvalue Assignment of Linear Systems

FACULTY NAMES

Dr. Susan Schneider and Dr. Edwin Yaz, EECE Department

STUDENT NAME

Wenyan Min, M.S. Student, EECE Department

INTRODUCTION

Since the stability of a linear system as well as the system's transient response are determined by the location of the system eigenvalues in the complex plane, the ability to assign the eigenvalues of a closed loop system is important in control system design [1].

SIGNIFICANCE

The stability and transient response of a continuous-tome or discrete-time closed loop linear system are related to the location of the eigenvalues of the controlled system in the left half of the complex s-plane or within the unit circle of the complex z-plane respectively. To ensure the desired degree of stability and/or desired transient response, the control system designer seeks to place the eigenvalues in appropriate locations. Many techniques exist to do this "pole assignment", including the use of Ackermann's formula [2] for the state feedback control, through which the designer attempts to place the closed loop system eigenvalues at exact locations. Other methods [3], assign the eigenvalues of the closed loop system to specific regions in the complex plane. Linear matrix inequalities can also be used to design feedback controllers to achieve regionalization of the eigenvalues of the closed loop system [4] and the LMI technique can be easily extended to nonlinear systems.

FORWARD THINKING/INNOVATION

We have been able to recast the regional eigenvalues placement feedback control design problem into the form of the discrete algebraic Riccati equation. This innovative alternate form of the design problem allows us to take advantage of software tools that have been developed for discrete time optimal control problems, specifically Matlab's DARE function [5]. Furthermore, this new technique allows the designer to locate the eigenvalues of the closed loop system in specific circular regions for not just discrete time systems but also continuous time systems.

STUDENT INVOLVEMENT

The student will use the discrete time Riccati equation formulation of the problem to find the gain matrix and output feedback for the closed loop system pole assignment. He will work with the faculty to ensure the poles are assigned to the desired locations. He will test if the technique is workable both theoretically and computational practically and investigate the optimality of the resulting controllers.

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PROJECT TITLE "Oral cancer awareness among Marquette University School of Dentistry patients"

FACULTY NAME Amir Seifi, DDS, PhD, Associate Professor, School of Dentistry
STUDENT NAMES Theresa Adamczyk, Michael Moran, Nicholas Tseffos, DDS candidates

INTRODUCTION

Approximately 42,000 people in the US will be newly diagnosed with oral cancer in 2013. Oral cancers have an 80 to 90% survival rate if found in the early stage of development. However, the majority of these diagnoses are made in the later stages of the cancer, accounting for the low associated 5-year survival rate of 55%[1]. Early detection is essential to decreasing morbidity and increasing survival. This is accomplished through regular oral exams conducted by health care practitioners and informed self-exams. This project, divided into three stages, is designed to assess the oral cancer awareness of newly screened patients at Marquette Dental School and to develop and validate educational materials provided to patients in the future. The first stage includes administering surveys to incoming patients regarding their awareness of oral cancer. The results will be analyzed in order to develop targeted educational materials in the second stage. These materials will be distributed to patients in the third stage. The appropriateness of the content and efficacy of their delivery will be determined in a follow-up awareness assessment.

SIGNIFICANCE

Misattribution of the signs and symptoms of oral cancer has been found to be the most significant barrier to patients seeking a timely consultation[2]. Preliminary analysis shows that 69% of participants had previously heard of oral cancer. Only 36% of participants could identify the associated significant signs, symptoms, and risk factors correctly. The surveys conducted in the first stage will be able to highlight the risk hallmarks of oral cancer that patients consistently misidentify. The development and distribution of educational materials will work directly to broaden patient understanding and correct misconceptions. The ultimate goal of this project is to promote earlier detection and to reduce the incidence and mortality of this disease amongst a well-informed patient population.

FORWARD THINKING/INNOVATION

While similar surveys have been conducted and documented previously, our particular findings will be utilized in the development of educational materials in multiple medias to better serve the unique learning styles of the our patients. Follow-up assessments to determine the program's effectiveness will guide the course of a school-wide instructional roll-out. The methods from all stages of this project can be utilized by other teams for the development of educational materials addressing other health-related issues.

STUDENT INVOLVMENT

The students have and will be involved at all stages of this project. They worked to develop the patient survey and are currently administering the survey to incoming patients and tabulating the results with the help of the project's statistician, Dr. Jessica Pruszynski. The students will participate in analyzing the survey results and designing the educational materials. They will also be responsible for distributing the educational materials and assessing their usefulness through a follow-up survey.

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PROJECT TITLE: "Dynamics of Hockey Skating"

FACULTY NAME: Barbara Silver-Thorn, PhD, Associate Professor, Biomedical Engineering
STUDENT NAME: Rebecca Tidman, BS, Doctoral Student, Biomedical Engineering

INTRODUCTION

Traditionally, hockey skate boots are very rigid, maximizing ankle stability. High boot stiffness holds the ankle in a relatively fixed position and may adversely affect knee and hip motion, potentially sacrificing speed and turning agility. In contrast to traditional hockey skates, the new Mako skate (Easton-Bell Sports) includes a flexible tendon guard, an asymmetric boot/blade/lacing design and thermoformed boot. The flexible tendon guard allows more ankle motion, thereby facilitating more knee and hip flexion. The intent of the asymmetric boot/blade/lacing design is to allow tighter turns. The thermoformed boot provides a tight fit, theoretically compensating for the greater ankle mobility while facilitating the transfer of force to the ground, providing for a more efficient push-off. Few studies have investigated the effect of hockey equipment design on speed, joint position and/or skate forces [1].

SIGNIFICANCE

The advent of the clap skate in the 1980s and its effects on speed and racing performance resulted in numerous biomechanical analyses of elite speed skaters [2]. In contrast, biomechanical analysis of hockey skating has been limited—despite the greater number of hockey versus speed skaters. Hockey biomechanics research thus far has been largely limited to injury prevention [3]. Hockey skating position or kinematics has not been thoroughly quantified. The effects of skate design (stiffness, blade position/geometry) on speed, turning and stopping have not been reported in the literature. Through a recent collaboration with Marquette University, Easton-Bell Sports and DC Hybrid Skating, the kinematic effects of skate treadmill training and skate design on performance have been investigated. The objective of the proposed study is to expand upon this research: to design sensors to measure skate down-force or stroke push-off and simultaneously measure these forces and limb position during skate treadmill testing. The primary objective of the proposed work is to develop the requisite sensors and instrumentation to measure skate down-force or stroke push-off. These sensors will be integrated with the current motion analysis system to enable simultaneous measurement of skate push-off force and limb position during skate treadmill testing. A future pilot study will then be conducted to investigate the effects of skate design (Easton Mako vs. Bauer Vapor APX2, the current market leader) on performance. The research hypothesis is that more flexible Mako skate will facilitate enhanced ergonomic position and biomechanical efficiency.

FORWARD THINKING/INNOVATION

While investigation of hockey skating kinematics has been limited, analysis of hockey skating forces or kinetics is even more unique. Only two studies of blade forces have been reported in the literature, both conducted at McGill University [1,4]. As such, the proposed instrumentation, test methodologies and results are novel and have the potential to influence hockey research, skate design, and hockey skater performance in the future. This research will also further Marquette's partnership with Easton-Bell Sports, creating additional opportunities to conduct hockey biomechanics research and equipment design.

STUDENT INVOLVEMENT

R. Tidman will be responsible for the skate blade load cell design, calibration and related pilot study, under the supervision of Dr. Silver-Thorn. The design will require mounting strain gage rosettes in the inner and outer surfaces of the skate blade. This design will create a vertical force load cell to measure skate down-force or stroke push-off. Duplicate load cells will be placed on both the front and back of the skate blade to investigate loading under the toes and heel. This blade load cell will be calibrated using free weights, as well as a materials testing machine. The instrumented skate will then be tested on a single subject during skate treadmill testing, establishing techniques and test procedures that can then be extended to a more formal pilot study. This work will be documented in R.Tidman's dissertation. Although the load cell design and testing will have limited undergraduate involvement due to the short-term nature of the project, the current kinematic research and future studies made possible by the proposed work have and will involve several undergraduate research assistants, exposing them to real-world applied biomechanics research.

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Project Title:"The Identification of Sex of Unknown Human Skeletal Remains by Analysis of Sex Chromatin"

Faculty Participants: Lela Franklin, Laboratory Specialist, Biomedical Sciences; Norman Sullivan, Ph.D., Associate Professor of Anthropology, Social and Cultural Sciences

Student Participant: Kaelin Rapport, Undergraduate Anthropology Major, Arts and Sciences

Introduction

The identification of sex of human skeletal remains is a fundamental procedure in forensic anthropology and bioarchaeological studies. Given the vagaries of preservation, it is often impossible to use the array of anatomical and statistical methods for the identification of sex of skeletal remains. DNA sequencing can provide an alternative. However, preservation sometimes inhibits a molecular approach. Beyond this, the amplification of ancient DNA is too expensive for regular and widespread application in bioarchaeology where hundreds of samples may have to be processed. Finally, archaeologists working outside the United States are often prohibited from removing any materials from the host country.

Significance

The proposed research is designed to test and refine a relatively new method of sex determination of unknown skeletal remains. Sex chromatin in osteocytes has been demonstrated to have utility in identifying sex from skeletal remains that have been interred for several years.[1] However, the utility of the technique remains undetermined for forensic cases with remains interred for more than a decade or in archaeologically derived skeletons.

The research will involve the hand preparation of undecalcified, thin sections (5 to 10μm) taken from cores of human bone.[2] Two thin sections will be made for each individual. One section will be stained with hemotoxylin eosin and examined under a light microscope at >100X for the presence of sex chromatin (to identify females). A second section will be stained with quinacrine mustard dihydrochloride and examined at 40X under exposure to UV florescent light (to identify males). Using both approaches should permit a positive identification of sex and will not rely on the absence of a particular microscopic feature to indicate sex. An additional benefit of identifying sex by thin sections of bone is that the age at death of the individual can also be determined with the same slides by application of standard histomorphic methods.[3]

Forward Thinking

This technique could become part of the standard protocol in the analysis of burials from archaeological sites and have use in forensic studies. For the latter, it will have great potential in cases involving buried and burned bodies. The technique will also have applicability in the determination of sex of nonadults. Secondary sex characteristics of the human skeleton do not develop until late adolescence. Consequently, there are limited means of determining the sex of archaeologically derived nonadult skeletons. This creates an impediment in the reconstruction of sex specific activity and health patterns in past human populations. This impediment can be overcome with the analysis of sex chromatin in human bone.

Student Involvement

Kaelin Rapport (2015), with support of Ms. Franklin and Dr. Sullivan, will prepare the samples. The analysis will involve all members of the team. After the results are collated, Mr. Rapport and Dr. Sullivan will collaborate in the assessment of replicability, statistical work and report preparation. .

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PROJECT TITLE: How do People Respond to Modern Forms of Discrimination? The Psychological and Physiological Consequences of Racial/Ethnic Microaggressions.

FACULTY NAME: Lucas Torres, PhD, Associate Professor, Department of Psychology
STUDENT NAMES: Leticia G. Vallejo, M.S., Amardeep Khahra, Jessica Sandoval

INTRODUCTION

Recent research has stipulated that modern forms of discrimination/racism involve more covert and insidious interactions that reflect bias towards an individual based on their race or ethnicity. These experiences have been termed racial/ethnic microaggressions and involve brief, everyday exchanges that convey denigrating, invalidating, and/or insulting messages.[2] Microaggressions tend to be subtle exchanges that are often transmitted automatically and unconsciously, can be intentional or unintentionally, can occur in ambiguous situations where alternative explanations are possible, and are more likely to happen when individuals pretend not to notice differences. As such, perpetrators of microaggressions often deny their existence, and often label the victim's response as an overreaction. Victims and witnesses are then left in a "catch-22" in which they have to decide whether 1) to respond and perhaps be perceived as hostile and hypersensitive or 2) to not respond and deal with the psychological and emotional consequences on their own. It is not only the discriminatory event itself, but also the uncertainty of the event that contributes to mental health problems for victims of microaggressions.[2] Therefore, the responses to a microaggression, by all involved; is essential in predicting the long-term effects of these events. The current study will use an experimental methodology to examine the physiological, behavioral, and emotional responses associated with witnessing a racial/ethnic microaggression.

SIGNIFICANCE

Investigating racial/ethnic microaggressions has significant implications for scholarship in mental health. As a relatively new field of study, it remains unclear the process by which targets and witnesses of microaggressions respond and/or cope with these ambiguous yet negative events. What are the physiological correlates associated with microaggressions? What kind of responses lead to healthy psychological outcomes? Do individuals who witness microaggressions identify these interactions as such? What behavioral, emotional, and physiological responses do they experience? Research with more overt forms of both racial and gender discrimination has found that confronting a perpetrator can lead to more positive outcomes for the perpetrator and target, including a decreased likelihood of discrimination by the perpetrator in the future.[1] This line of questioning helps researchers understand the context in which these negative events take place so as to inform the development of appropriate intervention strategies. Within the context of racial/ethnic microaggressions, confrontation on the part of bystanders may be more significant than in the case of overt discrimination, given that it could serve to validate the experience of the victim, and could lessen the effects of the "catch-22" of responding to the event.

FORWARD THINKING/INNOVATION

The empirical research examining racial/ethnic microaggressions continues to grow but, to date, minimal work has examined if and how witnesses respond to these events. A significant innovation of the current study is the implementation of experimental procedures to investigate these processes. That is, while the majority of research on racial/ethnic microaggressions rely on retrospective recall via traditional paper- pencil surveys, experimental methods allow researchers to capture real-life responses in the moment while controlling for key variables. Additionally, the present study will involve recruiting emerging adults to participate. Emerging adults (ages 18-25), represent a key demographic when it comes to being the victim of or a bystander of microaggressions. Young adults may not feel that they have the resources to deal with covert discrimination nor that it is their place to intervene when witnessing these events. Developmentally this is a critical period to help young adults establish the coping responses necessary to manage and stop discrimination that they can apply throughout their lifetime.

STUDENT INOVLVEMENT

Under the direction of Dr. Torres, Ms. Vallejo, Mr. Khahra, and Ms. Sandoval have been involved in the development of the experimental procedures examining the responses to witnessing a racial/ethnic microaggression. As such, they will be included as confederate participants in the various conditions of the experiment. Ms. Vallejo will be responsible for the recruitment of participants. Collaboratively with Dr. Torres; Ms. Vallejo, Mr. Khahra, and Ms. Sandoval will be involved in entering and analyzing the data from the experiment. Ms. Vallejo, Mr. Khahra, and Ms. Sandoval will present the findings at national and local professional conferences.

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PROJECT TITLE**:** **Exploring Expertise: Considering the Transition from Novice to Experienced STEM Teacher**

FACULTY NAMES(s): Leigh van den Kieboom, Assistant Professor, EDPL
Jill McNew Birren, Assistant Professor, EPDL
STUDENT(s) NAME: Mary (Alli) Williams, Graduate Research Assistant, EDPL

INTRODUCTION

President Obama has called for the creation of a national Science, Technology, Engineering, and Mathematics (STEM) Master Teacher Corps as a first step toward achieving his ambitious goal of preparing 100,000 STEM teachers over the next decade (Office of the Press Secretary, 2012). By focusing on STEM education, President Obama aims to improve U.S. student achievement in mathematics and science and ensure that U.S. students are adequately prepared to compete in and contribute to an increasingly high-tech global economy. One way to improve STEM education is to recruit and prepare expert STEM teachers who have both "deep content knowledge and strong teaching skills" (Office of the Press Secretary, 2012).

SIGNIFICANCE

Over the past 30 years, educational researchers have explored the knowledge needed for expert teaching, conceptualizing it as a unique blend of knowledge of content, pedagogy, curriculum, and student learning (Shulman, 1986). Because research consistently shows that a teacher's knowledge and expertise is an important factor that closely relates to student learning and achievement (Darling-Hammond, 2000), teacher education programs must design their preparation in such a way as to assist prospective teachers in acquiring and developing the different forms of knowledge needed for expert teaching. Current research documents the different types of knowledge an expert teacher has as well as the tasks of teaching included in an expert teachers' repertoire. However, a gap exists that explains *how* to support novice teachers in developing the knowledge and skills used by experts.

FORWARD THINKING/INNOVATION

The study is innovative because it recognizes that expert STEM teachers are needed to meet the challenges of improving the achievement of K-12 students in science and mathematics who are already falling behind their peers in other developed countries in science and mathematics (Russell, Hancock, & Mccullough, 2007). Teacher education programs must do more to prepare prospective teachers to become experts to keep pace with a global economy that trends toward an increase in science, technology, and innovation, and compete with the growing number of European and Asian professionals already working in these expanding science and technology fields (National Science Board, 2010). The results of the study will be used to seek external funding to conduct a larger-scale study that documents *how* to support novice STEM teachers in developing the knowledge and skills needed to perform as experts.

STUDENTS INVOLVEMENT

Mary (Alli) Williams (EDPL Graduate Research Assistant) will take an active role in this project, working in collaboration with Drs. van den Kieboom and McNew Birren and to analyze the data. Alli will use NVivo software to qualitatively analyze video-recordings of novice and expert STEM teachers teaching biology in a high-need urban high school.

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PROJECT TITLE: Structural Brain Changes Due to Intervention in Autism
FACULTY NAMES: Amy Van Hecke, Ph.D., Psychology; Robert Scheidt, Ph.D., Biomedical Engineering
STUDENT NAMES: Bridget Dolan, M.S., Clinical Psychology; Nicole Salowitz, Biomedical Engineering

INTRODUCTION

Social skills deficits among individuals with autism spectrum disorder (ASD) lead to isolation and lack of friendships. The Program for the Education and Enrichment of Relational Skills (PEERS) is an empirically based, manualized, outpatient treatment program designed to teach motivated adolescents with developmental delays the social skills needed in order to make and keep friends[1]. Previous studies assessing the PEERS program have found that adolescents demonstrated a shift to left-hemisphere EEG asymmetry, which was associated with more social knowledge and contacts and a decrease in symptoms of autism, as compared to a waitlist ASD group[2]. The latter study highlights the *functional* brain changes occurring at post-treatment; however, there is no known published study that has assessed *structural* brain changes following a social skills intervention for ASD.

SIGNIFICANCE

Linking neuroanatomical findings to behavioral symptoms associated with ASD (i.e., social communication deficits) is essential for understanding the role of structural changes in these individuals[3]. Despite inconsistencies in the literature, structural magnetic resonance imaging (MRI) research points to abnormalities in white matter in ASD. Furthermore, diffusion tensor imaging (DTI) techniques suggest that these volume abnormalities contribute to atypical structural and functional brain connectivity[3]. Both structural MRI and DTI methods indicate that young children with ASD experience an overgrowth of white matter, followed by a reduction in white matter in adolescence and adulthood[4-6]. Unlike adolescents with ASD, neurotypical individuals at this age experience an increase in white matter, which is vital for a smooth flow of information in functional networks[7].

FORWARD THINKING/INNOVATION

The neurological underpinnings of ASD are not fully understood, especially with regards to change to interventions targeting social skills. The proposed study seeks to understand white matter changes following a social skills intervention in adolescents with ASD. Given that neurotypical adolescents experience a growth in white matter, perhaps adolescents with ASD, who respond to the intervention, would show a similar increase in white matter volume. Examining the structural neural changes due to intervention will further our understanding of the connectivity patterns seen in ASD. The goal of the study is to understand if and how the PEERS intervention changes these structures (i.e., white matter) that affect connectivity. The study has potential to demonstrate that an intervention changes the brain to a more "healthy" structure in ASD, which has important public health and policy implications.

STUDENT INVOLVEMENT

Bridget Dolan, M.S., will take the lead on this project with the support of and collaboration with Dr. Amy Van Hecke, Dr. Robert Scheidt, and Nicole Salowitz. Ms. Dolan will recruit adolescents with ASD to participate in MRI/DTI sessions at two time points: one at pre-treatment and one at post-treatment (approximately 14 weeks apart). Five adolescents with ASD will be receiving the PEERS intervention while 5 adolescents with ASD will serve as waitlist controls. DTI (structural integrity of white matter neural tracts) will be calculated at the two time points, and the analyzed data between the two groups will be compared to see if white matter changes due to the PEERS intervention.

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PROJECT TITLE:"A Humanoid Robot Health Coach for Elementary School Student Obesity Intervention"

FACULTY ADVISORS: Andrew B. Williams, Professor and Raynor Endowed Chair, College of Engineering, and Robert Topp, Professor and Associate Dean of Research, College of Nursing
STUDENT NAMES: Elise Russell, ECE, Darryl Ramgoolam, BME, Kimberly Read, Exercise Physiology, Andrew Kuplic, Exercise Physiology

INTRODUCTION

The objective of this forward thinking research effort is to provide an innovative means for addressing the risk factor of physical inactivity and inadequate dietary knowledge related to the problem of obesity among elementary school children. This project will develop and validate a socially intelligent humanoid robot health coach to increase physical activity and dietary knowledge among elementary school children.

SIGNIFICANCE

Childhood obesity is a growing health problem in the United States. Indicators show that the rate of obesity for children age 12-19 years old has risen from 5% percent to 18% over the last ten years. Although strategies for solving this childhood obesity intervention range from educating parents about diet and enabling physical activity, one of the most successful (and expensive) clinical treatments for obesity is using personal health coaching for lifestyle modification.

FORWARD THINKING/INNOVATION

No one to our knowledge is using a social and mobile humanoid robot as a health coach for elementary school students. We know of no one that has integrated both physical activity health coaching and nutritional coaching into a single humanoid robot health coach. A program for a humanoid robot health coach could be a valuable tool for combating the childhood obesity epidemic directly in the school environment. Schools that could not afford a personal health coach for recess or after school programs could have a personal humanoid robot health coach to lead physical exercise and diet education coaching. Such a coach would ideally be optimized to learn and develop over time and to deliver obesity prevention programs of the same quality as humans.

STUDENT INVOLVEMENT

Students will lead the project and develop robot algorithms and programs for the Nao humanoid robot control, decision-making, dialogue, computer vision, and health coaching. Elise Russell and Darryl Ramgoolam will lead the project with Dr. Andrew Williams and Dr. Robert Topp, providing mentoring and advising. Students in exercise physiology, Kimberly Read, and Andrew Kuplic will provide health coaching input and leadership. The target study population will come from St. Anthony's School in Milwaukee with Dana Rodriguez, Director of the Padre Pio Clinic at the School providing direction and facilitation of the study.

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PROJECT TITLE: "A Teen-Sized Humanoid Robot Soccer Player with Emotions"
FACULTY ADVISORS: Andrew B. Williams, Professor and Raynor Endowed Chair
STUDENT NAMES: Adam Stroud, BME, Kellen Carey, COEN, Matthew Morris, ME, John C. Williams, CS, Joshua Panka, COEN, Corey Randolph, EE, Jerrell Jones, COEN, Elise Russell, ECE, Darryl Ramgoolam, Johannes Christian, Physics/Mathematics

INTRODUCTION

The objective of this project is to produce a teen-sized humanoid robot soccer that can express emotions while playing soccer with children. Although the original intent of the MU-L8 teen-sized humanoid robot was to play soccer with other robots in RoboCup, a novel application of MU-L8 would be for it to autonomously play soccer with children with developmental disabilities while expressing and reacting to emotion.

SIGNIFICANCE

Sometimes children with developmental and intellectual disabilities often are not included in sports activities that include playing with other children. With the lack of social interaction and playing partners, they often are not taught the rules of a particular sport. Organizations, such as the Special Olympics, provide support for these students but not all children have access to these programs. A humanoid robot soccer player that can express and react to emotions provides some of the social skills required to interact with a child with a developmental disability.

FORWARD THINKING/INNOVATION

A teen-sized humanoid robot that can play soccer interactively with a child could be used to teach a child how to play soccer and provide social interaction if the robot could display emotion. Currently there are no known robot soccer players that have been developed to play soccer with children and relate to them on a social and emotional level. The basic hardware for MU-L8 has been developed but the soccer playing software for vision, motion, decision-making, and locomotion have not been implemented. This project is a novel and forward thinking project that goes beyond the original intentions of MU-L8, which was just to play soccer with other robots.

STUDENT INVOLVEMENT

This is a student led project that will require computer programming of the interactive soccer playing and the development of a Smartphone Intuitive Likeness and Expression (SMILE) device. This project will lead by Adam Stroud, chief designer of MU-L8, and mentored and advised by Dr. Andrew Williams. The student development team will be divided into three sub-teams: child-robot interaction (J.C. Williams, C. Randolph, J. Jones), interactive soccer (J. Panka, K. Carey, M. Morris), and SMILE (A. Stroud, D. Ramgoolam, E. Russell, J. Christian).

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PROJECT TITLE

Deterministic and Stochastic Resilience Analysis for Time Optimal Control of Discrete-Time Systems

FACULTY NAMES

Dr. Edwin Yaz and Dr. Susan Schneider, EECE Department

STUDENT NAME

Jennifer Bonniwell, PhD Student, EECE Department

INTRODUCTION

In controller design, there are a variety of performance specifications that can be achieved. One of these specifications is the response time for a system to track a desired input, which is assessed by the error between the desired and actual results. For a time-optimal response, an n^{th} order discrete-time system will have the error reduced to zero in n-steps, which is achieved by designing a controller that places the poles of the closed loop system exactly at zero. When this controller is implemented in hardware, it will be susceptible to various uncertainties that could change the effective controller gains in the closed-loop system placing the closed-loop system poles somewhere other than zero and potentially causing the closed-loop system to become unstable. It is important to analyze the allowable deviation from the designed gains while being able to guarantee stability.

SIGNIFICANCE

Knowledge of the bound on the perturbations in the control gains gives hardware designers insight on the tolerances allowed in components as well as any environmental shielding that must be utilized. Some types of these uncertainties are deterministic and can come from tolerances in electrical component values such as resistors, capacitors, and inductors. There are also stochastic types of uncertainties that tend to come from the environment such as temperature, humidity, or radiation. Stochastic uncertainties can also be caused by noise in the system, i.e. noise on a ground plane within a PCB. These types of uncertainties are characterized by their statistics.

Due to both deterministic and stochastic uncertainties, the effective controller gains used for the closed-loop system will not be the exact values required, which could cause the closed-loop system to become unstable. By performing a resilience analysis, a bound on the deterministic perturbations can be found, as well as a bound on the variance of the stochastic perturbations. These bounds will aid in the implementation of a resilient controller design.

FORWARD THINKING/INNOVATION

In the proposed work, resilience analysis will be performed on the time-optimal discrete-time controller in [1] using analysis techniques from [2]. This analysis will give insight to such hardware parameters as the range of allowable component tolerances as well as the environmental enclosure required to limit the gain perturbations to be within the ranges determined in the analysis.

STUDENT INVOLVEMENT

The student will use the controller design from [1] and apply the resilience analysis techniques in [2] to determine the allowable range of perturbations while being able to maintain stability of the closed-loop system. She will work with the faculty to come up with the widest range of deterministic and stochastic perturbation magnitudes and variances, respectively, allowable while guaranteeing stability and will run simulations to ensure the closed-loop system will remain stable in the presence of gain perturbations within the determined bound.

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PROJECT TITLE: "Resilient Dynamic Feedback Control"
FACULTY NAMES: Edwin Yaz and Susan Schneider (Dept. of Electrical and Computer Engineering)
STUDENT NAME: Fan Feng (Dept. of Electrical and Computer Engineering)

INTRODUCTION

In this work, we consider a resilient dynamic feedback control design for continuous-time linear systems. A dynamic feedback controller consists of an observer-controller combination, where the observer estimates the internal state of the system and the controller uses the estimate instead of the actual state in a feedback action. It is very important that both the controller and the observer are resilient so that the convergence or performance of the system is still guaranteed when there are perturbations on the control or observer gains due to computational errors, round off errors or sensor errors, etc. The linear matrix inequality (LMI) technique is used in the design process [1].

SIGNIFICANCE

A controller for which significant performance deterioration occurs due to a small perturbation in the controller gain is referred to as a "fragile" or "non-resilient" controller [2]. Since more and more implementations of controllers and observers are done digitally, there are numerical round off errors in computation. Also, some implementations need manual tuning to obtain the best performance of the controller. For these reasons, it is desired to design a resilient controller that will have some tolerance to a change or readjustment of the control gain.

FORWARD THINKING / INNOVATION

For a dynamic feedback controller to be effective, the observer must respond much faster than the controller. However, it remains unclear whether perturbations on the observer gains or the controller gains have the more significant effect on the performance of the controller. Investigation will be made on the effect of perturbations on both observer gain and controller gain on the performance.

STUDENT INVOLVEMENT

In previous research regarding this problem, some preliminary theoretical results were derived. Based on the results, simulation studies of some benchmark systems will be developed for the proposed design method. Mr. Fan Feng will investigate the effect of the perturbations for controllers and observers, the maximum bounds of the perturbations and the relationship between pole positions and maximum bounds.

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Keywords