Forward Thinking Poster Session/Colloquy Presentation
Past Award Recipients

2014

The Role of Biocides in Antibiotic Resistance in Wastewater Treatment
Dr. Patrick McNamara, Assistant Professor, Civil, Construction and Environmental Engineering,
Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering,
Daniel Carey

Summary: Dan Carey is a PhD student working on this project. Thanks to awards from the forward thinking platform, Dan was able to purchase a computer and travel to Maryland to attend a short-course on bioinformatics. Dan used his newly acquired skills to analyze bioinformatics data for his dissertation. He has submitted his results for publication in *Environmental Science & Technology.* Dan is planning graduate with his PhD in May, 2016.

Removal of Environmental Estrogenic Micropollutants from Wastewater Solids
Dr. Patrick McNamara, Assistant Professor, Civil, Construction and Environmental Engineering,
Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering,
Thomas Hoffman

Summary: Thomas Hoffman was able to purchase lab supplies to help conduct his research. Thomas submitted a paper for publication in May to *Water Research* and has since graduated. Thomas is now a consulting engineering for HDR in Folsom CA.

Resilience in Adolescents Who Survived a Suicide Attempt from the Perspective of the Registered Nurse in a Psychiatric Facility
Dr. Abir Bekhet, Assistant Professor, College of Nursing,
Denise Matel-Anderson

Summary: The purpose of this qualitative study was to explore components of resilience (i.e. risk and protective factors) in adolescents who survived a suicide attempt from the perspective of nine nurses working with adolescents on two inpatient psychiatric units. The study used resilience theory as a guided theoretical framework which proposes that resilience is the interplay between risk factors and protective factors in face of adversity. ***On analysis of the focus group responses, three overarching categories emerged including risk factors, protective factors, and future recommendations of suicide prevention strategies.*** The perspectives gained from this study will be used to develop future nursing interventions to help adolescents overcome their risk factors and to build on their protective factors.

2013

Recovering from Foreclosure: An Experimental Study of a Community Outreach Campaign
Dr. Amber Wichowsky, Assistant Professor, Political Science,
Colleen Ross, Anabelle Martinez, members of POSC 4281

Anaerobic Membrane Bioreactor for Sustainable Wastewater Treatment
Dr. Daniel Zitomer, Professor, Civil, Construction and Environmental Engineering, Matt Seib

Sensorimotor Adaptation of Connected Speech using Multiple Acoustic Cues
Dr. Jeff Berry, Assistant Professor, Speech Pathology and Audiology; Dr. Michael T. Johnson, Professor, Electrical and Computer Engineering, Brittany Bernal

2012

Porting XINU to Raspberry Pi
Dr. Dennis Brylow, Associate Professor, Mathematics, Statistics and Computer Science, Matthew Bajzek, Farzeen Harunani, and Tyler Much

Neural Responses to Social Skills Intervention in Adolescents on the Autism Spectrum: An Extension of the PEERS Research Project
Dr. Amy Vaughn Van Hecke, Assistant Professor, Psychology and Sheryl Stevens

Case Study of the Implementation of the Co-principalship in a K-8 School District
Dr. Ellen Eckman, Associate Professor, Educational Policy and Leadership and Amy Porter

2011

Legal and Extra-Legal Factors Impacting Domestic Violence Injunctions in Milwaukee
Dr. Heather Hlavka, Assistant Professor, Social and Cultural Sciences; Dr. Sameena Mulla, Assistant Professor, Social and Cultural Sciences, Kate Hanson, and Chelsea Pierski

The Human Powered Nebulizer in the Treatment of Airway Diseases in El Salvador
Dr. Lars E. Olson, Associate Professor, Biomedical Engineering; Dr. M. Therese Lysaught, Associate Professor, Theology; Christopher Hallberg, Clinical Trial Coordinator; Ellen Hawkinson, Katelynn Kramer, Brian Laning, Sarah Schmiedel, and Andrew Weingart

Parent and Family Outcomes of PEERS: A Social Skills Intervention for Adolescents with Autism Spectrum Disorders
Dr. Amy Vaughn Van Hecke, Assistant Professor, Psychology, and Jeffrey Karst

2010

The Amader Gram Breast Care Palliation Study: Phase 1
Dr. Sheikh Iqbal Ahamed, Associate Professor, Mathematics, Statistics and Computer Science, 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

Marquette International Research Poster Session
Historical Award Winners

2014

"Engineering Synthetic Feedback to Promote Recovery of Self-feeding Skills in Stroke Survivors." (in partnership with the University of Genoa)
Dr. Robert Scheidt, Professor, Biomedical Engineering
Alexis Krueger, Graduate Assistant, Biomedical Engineering

"The Nahuatl in Central American Mapping project."
Dr. Laura Matthew, Associate Professor, History Department
Benjamin Nestor, Graduate Assistant, History Department

2013
"Designing Human-Computer Interfaces for Elderly People in Taiwan"
Dr. Sheikh Iqbal Ahamed
Professor, Mathematics, Statistics and Computer Science

"Untold Stories: An African Society and the Second World War (Nigeria)"
Dr. Chima J. Korieh
Associate Professor, History Department

Judges:
Dr. Joyce Wolburg, Associate Dean and Professor, Diederich College of Communication
Dr. Lars Olson, Interim Bio-Medical Chair, Biomedical Engineering

2012
"The Mechanism of 'Chinese Traditional Teeth Tapping' in Maintaining Alveolar Bone"
Dr. Dawei Liu, DDS
Associate Professor, Dental Developmental Sciences/Orthodontics

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

Judges:
Dr. Anne Pasero, Chair and Professor of Spanish, Foreign Languages & Literatures
Dr. James Marten, Chair/Professor, History
Ms. Michelle Schuh, Assistant Dean, College of Health Sciences

2011
"Circulations: Death and Opportunity in Southern Pacific Mesoamerica, 1450-1620"
Dr. Laura Matthew
Assistant Professor, History

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

Dr. Iqbal Ahamed
Associate Professor, Mathematics, Statistics and Computer Science

Judges:
Dr. Ellen Eckman, Associate Professor/Chair, Educational Policy and Leadership
Dr. John Pustejovsky, Associate Professor of German/Chair, Foreign Languages & Literatures
Dr. Ruth Ann Belknap, Associate Professor, College of Nursing

2010
Dr. Stephani Richards-Wilson
Assistant Dean for Recruitment and Retention, Klingler College of Arts and Sciences
Dr. M. Therese Lysaught
Associate Professor/Director of Graduate Studies, Theology

Dr. Lars Olson
Associate Professor, Biomedical Engineering

Dr. Sharon Chubbuck
Associate Professor, Educational Policy and Leadership

2009
"The "Itinerant Museum": Agrarian Reform, Peasant Revolt, and the Cultural Policy of Spain's Second Republic"
Dr. Eugenia Afinoguenova
Associate Professor of Spanish, Foreign Languages an Literatures

"Vamos Juntas: A pilot participatory action research project to assist Spanish speaking immigrant women in moderating life stressors"
Dr. Ruth Ann Belknap
Associate Professor, College of Nursing

"Muslim Outreach for Interfaith Dialogue: Al-Risala Movement's Mission for the 21st Century"
Dr. Irfan Omar
Associate Professor, Theology

"Emergency dental care training for refugee health providers: An answer to dental care access in long-term refugee camps"
Dr. Toni Roucka
Assistant Professor and Predoctoral Program Director of General Dentistry, General Dental Sciences

Table of Contents

COLLOQUY PRESENTERS

PROJECT TITLE

Reclaiming the Relevance of Faith in Catholic Education and Jesuit Identity

FACULTY NAME

Dr. Noel S. Adams

STUDENT NAME

Timothy Rothhaar

INTRODUCTION

The 1990 apostolic constitution of Pope John Paul II, *Ex Corde Ecclesiae,* defines and describes the nature of Catholic institutions of higher education. The defining features and purposes include a dialogue between faith and reason and an emphasis on interdisciplinary studies. Both of these are integral for promoting "a greater love for truth" and a holistic "vision of reality" in conjunction with the proclamation of the gospel. All this is necessary for students to receive a full and proper education at a Catholic university, in stark contrast with secular universities.

SIGNIFICANCE

In keeping with the guidelines of *Ex Corde Ecclesiae*, one of the four pillars of Marquette University's Mission Statement is faith, expressing Catholic identity in "the cultivation of our [Marquette's] religious character" and in "support of Catholic beliefs and values." Faith, however, is mentioned only *once* in the university's strategic plan "Beyond Boundaries," and even then it is glossed over as if it is not essential to establishing Marquette as "a highly ranked destination university." In our view, Marquette's strategic plan is not in keeping with *Ex Corde Ecclesiae's* emphasis on the central role that faith should play at a Catholic university. Our project aims to correct Marquette's current problematic direction, which in our view both overlooks and undervalues the role that faith should play in the classroom and in academic research projects funded by the university. As symptomatic of this problematic direction, we point out the unfortunate current climate problems at Marquette University: many students who take their faith seriously report that they feel they must keep their faith concerns to themselves, instead of giving an academic expression of their faith concerns, in fear of retribution from faculty or administrators who are either hostile or lukewarm to the Catholic faith. Students of faith should not have to worry about integrating their faith into their academic endeavors—especially at a Catholic, Jesuit university.

FORWARD THINKING/INNOVATION

We are currently organizing a student-centered, interdisciplinary conference to be held at Marquette University in which these themes are the centerpiece. Students from all disciplines will be encouraged to submit papers on the theme of the relevance of faith for their disciplines. Papers will be given in front of a university audience. A speaker of national esteem on these issues (e.g., Alasdair MacIntyre, Kenneth Garcia, Mark Noll, George Marsden) will be invited to give a keynote address. Outstanding conference papers will then be assembled for publication with a suitable publisher. After the conference at Marquette, there will be a follow-up session at the American Catholic Philosophical Association (in cooperation with Philosophers in Jesuit Education) in which students from Catholic universities will carry forward this discussion at the national level. Getting a "Jump Start" grant will make a crucial difference for us.

STUDENT INVOLVEMENT

Timothy Rothhaar, a PhD graduate student in the philosophy department, is assisting Dr. Noel Adams in organizing this conference and will help to assemble the collected papers for publication.

REFERENCES

John Henry Newman, The Idea of a University (University of Notre Dame Press, 1982)

Charles Taylor, *A Secular Age* (Harvard University Press, 2007)

Alasdair MacIntyre, *God, Philosophy, Universities: A Selective History of the Catholic Philosophical Tradition* (Rowman & Littlefield Publishers, 2011)

Garcia, Kenneth, *Academic Freedom and the* Telos *of the Catholic University* (Palgrave Macmillan 2012)

Jacques Maritain, *Education at the Crossroads* (Yale University Press, 1971)

Andrew Wright, *Religion, Education and Post-Modernity* (RoutledgeFalmer, 2004)

PROJECT TITLE: Identifying low frequency DNA variants in cancer patients
FACULTY NAME: Serdar Bozdag, PhD, Assistant Professor, MSCS
STUDENT NAME: Vatsal Mehra, Bioinformatics Masters Student

INTRODUCTION

Cancer is a genetic disease caused by the accumulation of DNA variants such as single nucleotide changes or insertions/deletions in DNA. DNA variants can cause silencing of tumor suppressor genes or increase the activity of oncogenes. In order to come up with successful therapies for cancer patients, these DNA variants need to be identified accurately. DNA variants can be identified by comparing DNA sequence of tumor tissue to a non-tumor tissue by using next generation sequencing technology. The problem of variant detection becomes especially hard if the variant occurs only in a small subpopulation of the tumor tissue. It becomes a challenge to distinguish these low frequency variants from sequencing errors, which are common in today's next generation sequencing methods [1]. Several computational tools have been implemented to identify low frequency variants in cancer [2]. However, it has been previously shown that there is low concordance in the results produced by these tools [3]. In this study, we aim to utilize the results of these variant callers to produce consensus output with higher accuracy than any of the individual tool.

SIGNIFICANCE

Accurate detection of low frequency variants has a multitude of applications such as identifying rare RNA transcripts to expand human and microbial variation databases, identifying somatic mutations and sub-clones in a population of tumor cells and making therapy decisions in clinical settings for individual patients. Moreover, this sensitive detection can allow investigators to identify early onset or relapse of some cancers. Since sample preparation and sequencing errors can contaminate the results, it becomes extremely hard to confidently call single nucleotide polymorphisms (SNPs) as a true variant.

FORWARD THINKING/INNOVATION

Although there has been a previous comparison analysis between different variant callers [4], to the best of our knowledge there is no existing method that utilizes the results of variant callers to come up with a consensus result with high accuracy. Our tool will combine the strengths of these individual tools, reduce their weaknesses, and thereby produce more accurate results than individual tools.

STUDENT INVOLVEMENT

Vatsal Mehra will be developing the method under the supervision of Dr. Serdar Bozdag. This project will be part of Vatsal's masters thesis. He will be running existing variant callers, comparing their results and subsequently devising a novel method to increase accuracy in detecting low frequency variants. The method will then be tested and validated on real clinical data.

REFERENCES

[1] van Dijk et al. (2014). Library preparation methods for next-generation sequencing: tone down the bias. Experimental Cell Research, 322(1), 12–20. http://doi.org/10.1016/j.yexcr.2014.01.008

[2] Koboldt et al. (2012). VarScan 2: somatic mutation and copy number alteration discovery in cancer by exome sequencing. Genome Research, 22(3), 568–576. http://doi.org/10.1101/gr.129684.111

[3] O'Rawe et al. (2013). Low concordance of multiple variant-calling pipelines: practical implications for exome and genome sequencing. Genome Medicine

[4] Xu, H. et al. (2014). Comparison of somatic mutation calling methods in amplicon and whole exome sequence data. BMC Genomics, 15(1), 244. http://doi.org/10.1186/1471-2164-15-244

TITLE: "An Intersectional Investigation of Minority Stress Theory"
FACULTY: Ed de St. Aubin, Ph.D., Associate Professor, Psychology
STUDENT: Lauren Yadlosky, M.S., Clinical Psychology Doctoral Student

INTRODUCTION

Perceptions are powerful and often more influential than reality itself. Our perceptions of how others view us shape our personal identities and interactions with the world.[1] Thus, minority group members' identities and interactions are shaped by the regular and systemic prejudice and discrimination they face. This constant marginalization creates significant physical and psychological strain that leads to significantly poorer biological and psychological health outcomes in minority populations.[2] Psychologists have documented and conceptualized this health disparity facing minority individuals via Minority Stress Theory (MST). This theory suggests that negative, chronic social stressors (e.g., stigma, prejudice, and discrimination) that minority individuals face on a daily basis create hostile environments that lead to increased negative psychological outcomes within these populations.[3]

Importantly, however, an individual has multiple identities that carry different internal and external perceptions. For example, individuals are not merely White or Black or Latino, they also have a gender identity, sexual orientation, socio-economic status, religious identity, etc. Research has demonstrated that the "double jeopardy" in terms of compounded stress associated with multiple minority statuses is complicated, occurring for some but not others.[4] The theory of intersectionality seeks to understand how an individual's multiple identities work together to shape their individual experience.[5] Intersectional theory acknowledges that one's experience and access to various support systems depends on these power dynamics and thus parallels the major tenets of MST.

However, the practical exploration of MST via an intersectional lens proves difficult with standard quantitative psychological methods. Social scientists have difficulty gathering enough participants from each of the increasingly intersectional groups (e.g., Black, lesbian, working class; White, lesbian, working class; Hispanic, lesbian, working class, etc.). To combat this, researchers often limit the intersections they explore. This introduces significant bias into the findings, as we draw conclusions on a superordinate level that do not apply to various intersections within that level.[5] Thus, the understanding of MST and its application to addressing the health disparity facing minority population is inherently limited.

SIGNIFICANCE

The proposed research aims to combat the significant gap in the literature by fusing "top-down" MST measures with "bottom-up" measures more sensitive to a variety of intersections. Researchers will also apply intersectional principles to quantitative measures, thus necessitating a pilot study exploring these measures and methodologies alongside one another. This work will theoretically and practically expand the existing MST framework and allow researchers to more fully understand the disproportionate disenfranchisement of marginalized groups. The methodologies under development provide researchers with a feasible way to study groups and research questions traditionally excluded from scientific study for "statistical reasons." Combining these various theoretically driven methodologies in this unique paradigm will help scholars, researchers, and clinicians address the health disparities plaguing minority populations. The resulting research program will acknowledge, appreciate, and celebrate diversity at an intersectional level – the way individuals experience it in their daily lives.

FORWARD THINKING/INNOVATION

This specific project will serve as a pilot for future work that will require significant financial support from external sources. As such, the current project has two specific research objectives. The first of these is methodological in nature as researchers will pair existing MST measures with more intersectional measures of identity and minority stress. A preliminary investigation using this framework with race has been successfully demonstrated. Second, researchers will determine the best application of statistical analyzes that meaningfully capture the relationship between intersections and MST. Future work will fuse this paradigm with physiological measures of stress, generating a translational approach to the health disparities crisis.

STUDENT INVOLVEMENT

This project has been largely conceptualized by graduate student, Lauren Yadlosky, who will act as project coordinator. She will continue to conduct a thorough literature search on both MST and intersectionality to design the necessary survey materials. Once responses are collected, Lauren will be primarily responsible for analyzing data and incorporating findings into large, external grant proposals. Significant external funding will be necessary to conduct the psycho-physiological follow-up to the current project, which will serve as Lauren's dissertation.

REFERENCES

[1]Cooley, 1902. *Human nature and the social order.*
[2]Lick, Durso, & Johnson, 2013. *Perspectives on Psychological Science, 8*(5), 521-48.
[3]Meyer, 2003. *Psychol. Bull., 129*(5), 674-97.
[4]Hayes, Chun-Kennedy, Edens, & Locke, 2011. *Jour. of College Counseling, 14*, 117-126.
[5]Cole, 2009. *Amer. Psychologist, 64*(3), 170-180.

Project Title: Goodnight Moon: Advancing the Understanding of Adolescent Type 1 Diabetes Mellitus Management

Faculty Name(s): Astrida Kaugars, Ph.D., Associate Professor, Department of Psychology

Student Name(s): Ashley Moss, M.S., Doctoral Program in Clinical Psychology; Natalie Benjamin, B.A., Doctoral Program in Clinical Psychology

Introduction: Sleep is extremely important for the development of children and adolescents[1]. Poor sleep has been associated with impairments in cognitive functioning and elevated rates of depressive symptoms in healthy adolescents[2,3]. Adolescents with chronic illnesses such as type 1 diabetes mellitus (T1DM) may experience greater sleep difficulties than healthy youth, and their sleep may be impacted by illness-related sequelae[4,5]. Additionally, depressive symptoms are high in adolescents and especially high in those with T1DM. Levels of depressive symptoms in youth with diabetes are two to three times higher than in youth without diabetes[6]. Furthermore, depressive symptoms and self-control have both been linked to lower glycemic control and poorer illness management in this population[7,8]. Thus it is necessary to investigate how these processes - sleep, depression, self-control, glycemic control, and illness management - are related among adolescents with T1DM.

Significance: Previous research has shown that treatment adherence is one the most effective ways to maintain near normal glycemic control, which has been implicated in mitigating the health risks and complications associated with T1DM. Both depressive symptoms and self-regulation have been independently linked to sleep and glycemic control, but there is a paucity of research on how sleep may influence adolescents' ability to effectively manage their T1DM. The proposed study aims to examine the relationship between sleep and treatment adherence and glycemic control in adolescents, and particularly the potential mediational role of self-control and depressive symptoms. Findings will serve to inform clinicians and healthcare providers about specific mechanisms that affect adolescents' ability to manage and regulate their chronic illness.

Forward Thinking/Innovation: The proposed study will be the first to examine how aspects of sleep quality (e.g., sleep disturbances, daytime sleepiness, total sleep time) are associated with psychosocial factors (i.e., depression and self-regulation) and diabetes management outcomes (i.e., treatment adherence and metabolic control) among adolescents with T1DM. Additionally, this study will use a newly-developed assessment of nighttime waking, which will serve to explore and highlight diabetes-specific reasons for nighttime waking in this population. The study will involve cross-disciplinary collaboration between Marquette University and pediatric diabetes clinics at the Children's Hospital of Wisconsin and Cincinnati Children's Hospital Medical Center. Families will be invited to complete paper or online questionnaires.

Student Involvement: Ashley Moss and Natalie Benjamin, clinical psychology graduate students, will carry out research-related activities under the direct supervision and in collaboration with Dr. Kaugars. The graduate students will be responsible for all aspects of the study implementation, data collection, and result dissemination.

References

[1]Palermo, T. M., Toliver-Sokol, M., Fonareva, I., and Koh, J. L. (2007). Objective and subjective assessment of sleep in adolescents with chronic pain compared to healthy adolescents. *Clinical Journal of Pain*, *23*(9), 812-20. doi: 10.1097/AJP.0b013e318156ca63

[2]National Sleep Foundation (2013). *Teens and Sleep*. Retrieved from http://sleepfoundation.org/sleep-topics/teens-and-sleep

[3]Morrison, D.N., McGee, R., & Stanton, W.R. (1992). Sleep problems in adolescence. *Journal of the American Academy of Child and Adolescent Psyciatry, 31*, 94-99. doi: 10.1097/00004583-199201000-00014

[4]Hysing, M., Sivertsen, B., Stormark, K. M., Elgen, I., & Lundervold, A. J. (2009). Sleep in children with chronic illness, and the relation to emotional and behavioral problems--a population-based study. *Journal of Pediatric Psychology, 34*(6), 665-670. doi: 10.1093/jpepsy/jsn095

[5]Ahmet, A., Dagenais, S., Barrowman, N. J., Collins, C. J., & Lawson, M. L. (2011). Prevalence of nocturnal hypoglycemia in pediatric type 1 diabetes: A pilot study using continuous glucose monitoring. *The Journal of Pediatrics*, *159*(2), 297-302. doi: 10.1016/j.jpeds.2011.01.064

[6]Hood, K. K., Huestis, S., Maher, A., Butler, D., Volkening, L., & Laffel, L. M. (2006). Depressive symptoms in children and adolescents with type 1 diabetes: Association with diabetes-specific characteristics. *Diabetes Care, 29*(6), 1389-1391. doi: 10.2337/dc06-0087

[7]McGrady, M. E., Laffel, L., Drotar, D., Repaske, D., & Hood, K. K. (2009). Depressive symptoms and glycemic control in adolescents with type 1 diabetes: Mediational role of blood glucose monitoring. *Diabetes Care, 32*(5), 804-806. doi: 10.2337/dc08-2111

[8]Berg, C. A., Hughes, A. E., King, P. S., Korbel, C., Fortenberry, K. T., Donaldson, D., . . . Wiebe, D. J. (2014). Self-control as a mediator of the link between intelligence and HbA1c during adolescence. *Children's Health Care, 43*(2), 120-131. doi: 10.1080/02739615.2013.837819

PROJECT TITLE

Molecular and cultural methods of quantifying virus removal by electrocoagulation

FACULTY NAME

Brooke Mayer, PhD, PE

STUDENT NAME

Joe Heffron

INTRODUCTION

Electrocoagulation (EC) is the *in situ* production of coagulant by passing electrical current through a sacrificial electrode. EC has been shown to be effective at removing a wide range of pollutants, including metals, organic micropollutants, and oil and grease.[1,2,3] Recently, EC has also been considered for mitigating viruses in drinking water.[4,5,6] EC has shown promising results in removing the bacteriophage MS2, surpassing the Surface Water Treatment Rule of 99.99% reduction of viruses.[4,5] EC also outperforms conventional chemical coagulation for bacteriophage removal.[4,5] However, the mechanisms of virus removal are still poorly understood, and research to date has relied on a single model bacteriophage to represent the wide array of water-borne viruses.[4,5,6]

SIGNIFICANCE

Viruses account for an estimated 30 to 40% of infectious diarrhea in the U.S.[7] Several viruses are included in the Environmental Protection Agency's (EPA) Contaminant Candidate List for drinking water.[8] Although many viruses are only moderately tolerant of conventional water treatment,[9] some enteric viruses, *i.e.*, adenoviruses, show high resistance to emerging treatment technologies such as UV disinfection.[8]

FORWARD THINKING/INNOVATION

The Marquette University Water Quality Center will investigate the mechanisms of virus removal from drinking water via EC. To our knowledge, these experiments will be the first to test EC on human and mammalian viruses in addition to bacteria-infecting viruses (bacteriophages). The research will also contribute to methods for quantifying virus removal. In particular, our team hopes to compare molecular and cultural methods. While cultural methods provide insights that molecular methods cannot, molecular methods are far less labor-intensive and costly. Delineating the tradeoffs between methods of quantifying virus removal will pave the way for greater efficiency in future research.

STUDENT INVOLVEMENT

With Dr. Mayer's guidance, Joe Heffron, a PhD student with his Master's degree from Marquette, will lead the project design, experimentation and dissemination of results.

REFERENCES

[1] I. Kabdasli, T. Arslan, T. Olmez-Hanci, I. Arslan-Alaton, and O. Tunay, "Complexing agent and heavy metal removals from metal plating effluent by electrocoagulation with stainless steel electrodes," *J. of Haz. Mat.*, vol. 165, pp. 838 - 45, 2009.

[2] S. Govindaraj, M., Sudhir, A., Sukumar, C., Hariprakash, B., Pattabhi, "Treatment of Endocrine Disrupting Chemical from Aqueous Solution by Electrocoagulation," *Separation Sci. and Tech.*, vol. 48, no. 2, pp. 295-302, 2013.

[3] X. Chen, G. Chen, and P. L. Yue, "Separation of pollutants from restaurant wastewater by electrocoagulation," *Separation and Purification Tech.*, vol. 19, no. 1 - 2, pp. 65 - 76, 2000.

[4] C. Tanneru, J. Rimer, and S. Chellam, "Sweep flocculation and adsorption of viruses on aluminum flocs during electrochemical treatment prior to surface water microfiltration," *Environ. Sci. Technol*, vol. 47, pp. 4612 - 4618, 2013.

[5] B. Zhu, D. Clifford, and S. Chellam, "Comparison of electrocoagulation and chemical coagulation pretreatment for enhanced virus removal using microfiltration membranes," *Water Res.*, vol. 39, pp. 3098 - 3108, 2005.

[6] C. Tanneru and S. Chellam, "Mechanisms of virus control during iron electrocoagulation-microfiltration of surface water," *Water Res.*, vol. 46, pp. 2111 - 2120, 2012.

[7] Blacklow, N.R., and Greenberg, H.B. "Viral gastroenteritis," *N Engl J Med.*, vol. 325, pp. 252 – 264, 1991.

[8] Gerba, C., Gramos, D., and Nwachuku, N. "Comparative inactivation of enteroviruses and adenovirus 2 by UV light," *Appl Environ Microbiol, vol. 68(10), pp.* 5167–5169, 2002.

[9] CDC. "Effect of Chlorination on Inactivating Selected Pathogen," Accessed: 11-2-2015. Available at: http://www.cdc.gov/safewater/effectiveness-on-pathogens.html

PROJECT TITLE

Design of a Process to Recover Fertilizer from Wastewater While Removing Micropollutants

FACULTY

Brooke K. Mayer, Ph.D., PE, Assistant Professor & Patrick J. McNamara, Ph.D, Assistant Professor, Civil, Construction and Environmental Engineering

STUDENT

Yiran Tong, Ph.D. Student, Civil, Construction and Environmental Engineering

INTRODUCTION

In the proposed research a flow-through column system will be built to sequentially remove organic micropollutants (chemicals such as antibiotics that are often found in wastewater) and recover nutrients from wastewater effluent. Biosolids-dervied biochar, which can be produced on-site at wastewater treatment plants, and ion-exchange resins will be used as the sorbent materials. The results will help provide a method to recover a valuable resource, i.e. nutrient-rich fertilizer, while removing contaminants from water, and will further the development of sustainable water treatment plants.

SIGNIFICANCE

Water reuse is, and will continue to be, one of the main issues of the 21st century. Recycled water can be a significant source of nutrients (phosphorus and nitrogen, which are critical components of agricultural fertilizer). As water is reused it also accumulates organic micropollutants such as antimicrobials and pharmaceuticals. Micropollutants are a concern because they can elicit major biological changes at very small (ng/L) concentrations. A major issue for resource recovery from wastewater is determining how to recover water and valuable nutrients that are free from micropollutants.

FORWARD THINKING/INNOVATION

The majority of the existing research on micropollutants has been conducted independently from nutrient work and vice versa, even though each of these constituents likely impacts removal efficiency of the other. In our research, the fate of micropollutants is considered while recovering nutrients to ensure separation of potentially harmful micropollutants from the valuable nutrient products. We will also use biosolids-derived biochar as an adsorbent, which develops an alternative potential usage of biosolids, providing very promising potential for further development of sustainable water management.

STUDENT INVOLVEMENT

Ms. Tong will be responsible for running experiments and analyzing data. She will present the results of this work and assist in the composition and submission of journal manuscripts.

REFERENCES

1. Mayer, B.K., Gerrity, D., Rittmann, B.; Reisinger, D., Brandt-Williams, S. (2013) “Innovative Strategies to Achieve Low Total Phosphorus Concentration in High Water Flows,” *Critical Reviews in Environmental Science and Technology*, 43(4), 409-441

2. McNamara, P.J., Wilson, C., Wogen, M.W., Murthy, S., Novak, J.T., Novak, P.J. (2012) “The Effect of Thermal Hydrolysis Pretreatment on the Anaerobic Degradation of Nonylphenol and Short-Chain Nonylphenol Ethoxylates in Digested Biosolids,” Water Research, 46(9), 2937-2946.

PROJECT TITLE

Advanced treatment processes for the reduction of estrogenic compounds in potable water

FACULTY NAME

Dr. Patrick J. McNamara

STUDENT NAME

Mrs. Emily K. Maher (Gorsalitz)

INTRODUCTION

Estrogenic compounds have been widely studied, and are known to have significant negative impacts on aquatic ecosystems and human health. Estrogens can pass through wastewater treatment plants where they are inevitably discharged into surface waters. In conventional drinking water treatment, estrogen removal is variable, and at times removal is less than 20 percent. This research investigates the estrogenic treatment potential of electrocoagulation – a drinking water treatment process that could be used in point-of-use applications. The goal of this research was to determine the removal efficiency and mechanism of removal of four estrogenic compounds. Electrocoagulation experiments have been performed in a bench-scale electrocoagulation reactor. Estrogens were quantified by LC-MS.

SIGNIFICANCE

Estrogens adverse effects on aquatic ecosystems and human health include the disruption of development and function of reproductive systems. The concern surrounding human health in this research resulted from the known effects on wildlife. Specifically, the exposure to fathead minnows of synthetic estrogen resulted in the feminization of the minnows and near extinction of the population. The uncertainty of the human health effects of these compounds has resulted in some being listed on the EPA's Contaminant Candidate List and the removal of these compounds will likely reduce the risk to human and ecosystem health.

FORWARD THINKING/INNOVATION

Electrocoagulation as a point-of-use system for the removal of estrogens is a novel process for the reduction and proliferation of these compounds in the environment and in human exposure. Currently, little data is available regarding the removal efficiency and the mechanism of removal of estrogenic compounds using electrocoagulation.

STUDENT INVOLVEMENT

Mrs. Maher will continue to be responsible for the experiment design, running lab-scale experiments, sample and data analysis, and data presentation. She will assist in the preparation of publications and presentations of the resulting data.

REFERENCES

Chen C-Y, Wen T-Y, Wang G-S, Cheng H-W, Lin Y-H, Lien G-W. Determining estrogenic steroids in Taipei waters and removal in drinking water treatment using high-flow solid-phase extraction and liquid chromatography/tandem mass spectrometry. *Sci Total Environ*. 2007;378(3):352–65. doi:10.1016/j.scitotenv.2007.02.038.

Kidd, Karen A., et al. "Collapse of a fish population after exposure to a synthetic estrogen." *Proceedings of the National Academy of Sciences* 104.21 (2007): 8897-8901.

Datson GP, Cook JC, Kavlock RJ. Uncertainties for endocrine disrupters: Our view on progress. *Toxicol Sci*. 2003;74:245–252. doi:10.1093/toxsci/kfg015.

PROJECT TITLE

Pilot Project for Collaborative Research with Industry at the Global Water Center

FACULTY NAME(S)

Dr. Patrick McNamara, Dr. Brooke Mayer

STUDENT NAME(S)

Lee Kimbell

INTRODUCTION

The specific research goal of this project is to determine if biochar can be used at the end of a wastewater treatment plant for extra treatment to remove micropollutants, similar to how household water filters are used as additional drinking water treatment steps to filter water in our homes. Typically these household water filters employ activated carbon to remove contaminants, our idea is to utilize biochar as a filter for the micropollutants that are of increasing concern.

SIGNIFICANCE

The Milwaukee Metropolitan Sewerage District (MMSD) operates our local wastewater treatment plants, and produces a very useful product from the biosolids generated on site during treatment processes. The goal of this project is to examine the effectiveness of this product, biochar (which is produced from Milorganite), for removing contaminants of emerging concern from wastewater. These contaminants are referred to as micropollutants, and include chemicals such as pharmaceuticals, hormones, antimicrobial compounds, and many other organic compounds that are of high concern due to their capability to impact reproduction in fish species and disrupt ecosystem functionality after being discharged from wastewater treatment plants into receiving waters such as Lake Michigan and the Milwaukee River. Additionally, elevated concentrations of several of these compounds have been linked to increasing health problems and antibiotic resistance that can pose significant health risks for humans utilizing these sources for various purposes.

FORWARD THINKING/INNOVATION

As these types of contaminants continue to enter our wastewater and eventually our lakes and streams, it is our responsibility as a forward thinking society to develop technologies capable of removing these compounds. This research project is based on the motivation to protect our most precious resource, water, by utilizing a waste byproduct (biochar) as a filtering mechanism for wastewater. Water is an essential resource for human life, and as populations continue to increase the demand for high quality water supplies will increase exponentially. Additionally, the development of a sensor to obtain continuous measurements of micropollutants in the wastewater will be a novel development and could provide numerous applications to monitor water quality for scientists and other researchers.

STUDENT INVOLVEMENT

Lee Kimbell (Marquette graduate student) will be conducting research to determine the effectiveness of biochar as a micropollutant removal technology. Included in this task will be construction of the reactor, making biochar from MMSD's Milorganite, and conducting applicable research and tests using biochar as a micropollutant removal technology.

REFERENCES

N/A

PROJECT TITLE
Vision-based target following for an UAV using Bayesian Sensor Fusion

FACULTY NAME
Henry Medeiros, Ph.D., Assitant Professor, Electrical and Computer Engineering

STUDENT NAMES
Andres F. Echeverri, Electrical and Computer Engineering

INTRODUCTION

There has been significantly growing interest in robotic platforms for objects or pedestrian tracking and following within the computer vision and robotics communities. The design of such platforms usually involves several main elements: A tracker or trackers that are flexible enough to detect and follow different types of targets in different scenarios, a robust depth estimation mechanism, a robust mechanism for the detection and removal of false-positives or outliers and well tuned motion controls.

Vision-based tracking algorithms for robotic platforms must be flexible such that only a limited amount of information about the target must be known a priori. These algorithms must also be robust enough so that the platform can keep track of the target under a variety of conditions. Many existing platforms rely on defining some kind of "unique identifier" for the system to detect and track. This could be as simple as a specific color or shape [1], or as intricate as using known markers such as LEDs attached to the target. Although a certain level of robustness can be obtained by such approaches as long as the assumptions on the appearance of the target and the background are not violated, they lack the flexibility needed to make such systems practically useful [2]. Flexibility can be obtained by relying on discriminative trackers that can be initialized with the target appearance at the initial time and then updated on-the-fly [3]. These trackers can be endowed with additional robustness by integrating them with recursive Bayesian estimation methods that can effectively limit the number of opportunities for the algorithms to make mistakes.

SIGNIFICANCE

This work could change the way people use small UAV (Unmanned Aerial Vehicle). This project aims to devise the technology needed to create UAVs fully capable of autonomously tracking objects. This technology would be useful in industries such as film-making and surveillance. So far, there is no UAV capable of following an object robustly enough using computer vision techniques.

FORWARD THINKING/INNOVATION

So far, there are no UAVs capable of following objects without using mechanisms such as GPS or wireless beacons, which add constraints to the overall system and require the target to emit a signal. What if we could use a camera to detect and track the object without no previous information about it? This work is among the first to design an autonomous, low-cost, target following platform. The proposed system is flexible since it will not impose constraints on the shape or color of the target. This will be accomplished by using a combination of several trackers/detectors in a Bayesian approach.

STUDENT INVOLVEMENT

This is a research project under the guidance of Dr. Henry Medeiros developed by the student Andrés F. Echeverri, who is researching the different methods available today in the computer vision community. These methods will be tested and evaluated in a small drone.

REFERENCES

[1] C. Teuliere, L. Eck, and E. Marchand, “Chasing a moving target from a flying UAV,” in Intelligent Robots and Systems (IROS), 2011 IEEE/RSJ International Conference on, 2011, pp. 4929–4934, iD: 1.
[2] C. Hu, X. Ma, and X. Dai, “A robust person tracking and following approach for mobile robot,” in Mechatronics and Automation, 2007. ICMA 2007. International Conference on, 2007, pp. 3571–3576, iD: 1.
[3] G. Nebehay and R. Pflugfelder, “Clustering of static-adaptive correspondences for deformable object tracking,” in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2015, pp. 2784–2791.

PROJECT TITLE

Stereotypes: Profiling You Based on Your Utility Consumption

FACULTY NAME

Dr. Richard Povinelli

STUDENT NAME

Michele R. B. Malinowski

INTRODUCTION

As we move to more efficient technologies, faster communications, and larger storage devices, utility companies gather increasingly large quantities of data on their customers. The detailed records now allow utilities to identify daily or hourly patterns of behavior in their customers, allowing the classification of customers by these behavior patterns. These clusters permit targeted inspection, marketing, and conservation campaigns, improving the effectiveness of the utility's efforts.

SIGNIFICANCE

Clustering customers allows the utility companies to identify the stereotypical customers within each class. These customer classes can be targeted for marketing, conservation, or educational programs based on their stereotypical behaviors. Consumption that does not fit into the standard classes, outlier behaviors, may indicate unmetered usage or errors in the system, providing a valuable tool for troubleshooting and fault detection.

FORWARD THINKING/INNOVATION

Utility metering data is used to create statistical stochastic models of each customer. The models are compared to each other by forming a matrix of similarity. Finally, the models are clustered by their characteristics and the relationships between different models. These clusters are represented by a single stereotype, a behavior pattern that embodies that of the cluster it represents. The stereotypes behave as typical customers within that cluster, and provide consumption data useful for applying marketing campaigns. Outlier models falling outside the clusters are used to identify fault patterns (waste, theft, etc.)

STUDENT INVOLVEMENT

The research is being directed by and performed by the student.

REFERENCES

A. Albert and R. Rajagopal, "Smart Meter Driven Segmentation : What Your Consumption Says About You," vol. 28, no. 4, pp. 4019–4030, 2013.

E. Coviello, A. Chan, and G. Lanckriet, "Clustering hidden Markov models with variational HEM," *arXiv Prepr. arXiv1210.6707*, vol. 1, pp. 1–44, 2012.

T. Jebara, Y. Song, and K. Thadani, "Spectral Clustering and Embedding with Hidden Markov Models," *18th Eur. Conf. Mach. Learn. ECML 2007, Proc.*, vol. 4701, pp. 164–175, 2007.

C. Li and G. Biswas, "Applying the Hidden Markov Model Methodology for Unsupervised Learning of Temporal Data," *Int. J. Knowl. Based Intell. Eng. Syst.*, vol. 6, pp. 152–160, 2002.

D. Mavroeidis, "Mind the eigen-gap, or how to accelerate semi-supervised spectral learning algorithms," *Proc. Twenty-Second Int. Jt. …*, pp. 2692–2697, 2011.

A. Y. Ng, M. I. Jordan, and Y. Weiss, "On Spectral Clustering: Analysis and Algorithm," *Adv. Neural Inf. Process. Syst.*, pp. 849–856, 2001.

L. . Rabiner and B. H. Juang, "An introduction to hidden Markov models.," *IEEE ASSP Mag.*, vol. 3, no. January, pp. 4–16, 1986.

D. Spielman, "Spectral graph theory," 48th Annu. IEEE Symp. Found. Comput. Sci., pp. 29–38, 1997.

U. Von Luxburg, "A Tutorial on Spectral Clustering," *Stat. Comput.*, vol. 17, pp. 395–416, 2006.

PROJECT TITLE: Cognitive Flexibility and Psychotherapy Outcome

FACULTY: Michael Wierzbicki

STUDENTS: Benjamin T. Johnson, John Devine, Maribeth Gomez

INTRODUCTION

Cognitive-behavioral theory suggests that individuals who employ more effective cognitive and behavioral skills resolve stressors more successfully and experience less emotional distress than others. One factor related to effective coping is cognitive flexibility.

SIGNIFICANCE

Cognitive-behavioral therapy is a popular and empirically supported form of psychotherapy. Psychologists are interested in identifying factors that predict or enhance treatment outcome.

FORWARD THINKING/INNOVATION

A new measure of cognitive flexibility has been published (CFI; Dennis & Vander Wal, 2010) but has not yet been used in studies of therapy outcome. The planned research will administer this measure to clients to examine how it is related to therapy outcome.

A previous study by the authors developed a cognitive flexibility subscale of the Personality Assessment Inventory (PAI). The researchers will use archival data to examine how cognitive flexibility, as assessed by their newly developed subscale, is related to treatment outcome.

STUDENT INVOLVEMENT

Benjamin Johnson, a graduate student in Clinical Psychology, will use the CFI in his master's thesis research, to examine the relationship between cognitive flexibility and therapy outcome.

John Devine and Maribeth Gomez are undergraduates enrolled in Independent Study. They will work in the archival data collection process described above.

REFERENCES

Dennis, J. P., & Vander Wal, J. S. (2009). The cognitive flexibility inventory: Instrumental development and estimates of reliability and validity. *Cognitive Therapy and Research, 34(3),* 241-253.

PROJECT TITLE : Pain Level Measurement Using Facial Images

FACULTY NAME : Dr. Sheikh Iqbal Ahamed, Marquette University, Dr. Richard Love, IBCRF and Reza Salim, Amader Gram

STUDENTS NAME: Md Kamrul Hasan, Golam Mushih Tanimul Ahsan, Computational Sciences Doctoral Student.

INTRODUCTION:

More than 8 million people die globally each year from cancer. Three-quarters of these are reported to suffer from pain. A primary barrier to provision of adequate symptom treatment is failure to appreciate the intensity of the symptoms—most commonly pain--patients are experiencing. One difficulty for health care providers in helping patients with chronic conditions like cancers is having accurate, complete, and timely information about symptoms, daily information if possible. In particular, failure to use (repeatedly) validated symptom assessment tools prevents communication between patients and health-caregivers to bring attention to symptoms' issues. The usual way to obtain such information is to ask office-visiting patients standard questions about their symptoms and their intensities. For patients with cancer the most widely used questionnaires for this task are the Edmonton Symptom Assessment Survey (ESAS) or the Brief Pain Inventory. Common practice is to have patients provide answers on paper to these instruments when they are seen in doctors' offices. This practice of course means that the data obtained only cover the particular situation the patient is in at that time. So actual pain data are being out of reach in this situation.

SIGNIFICANCE:

In an ideal situation, to monitor patients more completely and know every day how patients feel and then of course to make adjustments in treatments, such as types, amounts and timing of pain medicines, it would be good to have data from such questionnaires every day. In studies where patients have home computers are associated with increased quality of life and survival in terminally-ill patients with lung cancer. In settings where hospice programs are available, patient and family satisfaction is clearly related to intensity of monitoring and consequent associated prompt adjustments of symptomatic managements. Management through phone contact, or email contact is usually limited, mostly because doctors are uncomfortable with their command of the full picture of the problems they are managing, but also because the practice of medicine has historically been based on face-to-face encounters. All of these issues are magnified in low- and middle income countries where limited access to care, sub-optimal quality of care and usually no hospice care at all, are the norms. One more practical way to make obtaining such more detailed symptom information possible and usable by physicians, is to put the questionnaires on a cell phone software platform, which the patient or his/her attendant could then complete at home and send by phone each day to a doctor's records/office.

FORWARD THINKING/INNOVATION:

We have designed and deployed a mobile based system for remote monitoring of pain intensity from facial images using a smart phone camera. In contrast to other systems for emotion or pain detection, we have deployed the healthcare tool and it has been tested in a clinical setting. But we have identified the issues regarding training and testing for better algorithm development for pain intensity detection. In addition, we have identified the design challenges to overcome the barriers to deploy the system for remote monitoring of pain intensity from facial expression.

STUDENT INVOLVEMENT:

Kamrul and Tanim are working on the algorithmic design and improvement of the system. Facial image data have been collected from the patients with advanced breast cancer in rural Bangladesh having IRB approval. Currently, more data are analyzed for the algorithmic development.

PROJECT TITLE : Non invasive way hemoglobin level measurement using smart phone.

FACULTY NAME : Dr. Sheikh Iqbal Ahamed, Marquette University, Dr. Richard Love, IBCRF and Reza Salim, Amader Gram

STUDENTS NAME: Md Kamrul Hasan, Golam Mushih Tanimul Ahsan, Computational Sciences Doctoral Student.

INTRODUCTION:

For medical health diagnosis, hemoglobin level assessment is an important part because it gives better understanding of general human health conditions. In many blood diagnostic laboratories, still it is calculated by shining light through a small volume of blood and using a colorimetric electronic particle counting algorithm. In this system, patients are needed to come to the diagnostic laboratory to give the blood that costs time and money. In addition, the laboratory requires equipment and facilities for the blood analysis. To overcome these problems, we have proposed a non invasive way to get the hemoglobin level value of our blood using smart phone video of a finger tip.

SIGNIFICANCE:

Hemoglobin level measurement is significantly important for sickle cell patient. In addition, it is necessary for diagnosis and triage of multiple medical conditions of chronic anemia. Sickle Cell Disease (SCD) is a chronic condition related to the deformed shape of red blood cell in human. In US about a hundred thousand people suffers from SCD. When hemoglobin level decreases, due to the deformed shape of red blood cells, the patients feel severe pain. Among the patients, about 99% are African Americans. About 22 percent of the patients who reported severe pain die during a pain episode. An average adult suffering from SCD is admitted to emergency department (ED) about four times a year and about 10 percent of the patients are admitted to the ED once per month. This amounts to an estimated cost of 1.1 billion dollars.

FORWARD THINKING/INNOVATION:

We have already collected data from the patients seen at the emergency department of Froedtert Hospital and Blood center of MCW, Milwaukee, Wisconsin. The sample set had a distribution of hemoglobin levels in three different groups: <9 g/dl, 9-13 g/dl, 13-16 g/dl. A single 30 second video was taken for each participants using a cell phone camera (with the flash on) pressed gently on the ventral bed (the pad) of the tip of the middle finger of the right hand, by the research coordinator. The ER physician investigator recorded the laboratory determined hemoglobin level (g/dl). Each video image of the finger-tip with the flash of the camera on was converted into three time series data: average of the red, green and blue pixels for each frame over 30 seconds.

For regression analysis, we compared the average of the red pixel intensities over all the frames during a 30 second video and the corresponding hemoglobin level measured at the laboratory by standard methods. We found significant concordance of the red pixel intensity by mini-video and the hemoglobin level by “gold standard” venipuncture laboratory testing with a linear least squared regression correlation coefficient (r) of 0.68. In exploring our data we summarized that red pixel color intensity at the fingertip might also be influenced by the thickness of the skin which in turn is age and gender-related (men have thicker skin, and thickness decreases with age) along with the hemoglobin level.

STUDENT INVOLVEMENT:

Kamrul and Tanim are working on the design and development of the data analysis algorithm and mobile application. The video of the finger tip are collected from the blood center of MCW by them. The video image data are analyzed based on the developed algorithm for better hemoglobin level prediction.

PROJECT TITLE: Crowd Flow Monitoring and Optimization

FACULTY NAME Dr. Sheikh Iqbal Ahmed, Marquette University and Dr. Muhammad Arif, Um-Alqura University, Saudi Arabia

STUDENT NAME: Piyush Saxena, and Tanvir Roushan, Marquette University

INTRODUCTION

Large crowd localization has become an important aspect of the twentieth century. Places such as religious gatherings, sport arenas to densely packed transportation hubs experience large volumes of people. Crowd control is a critical component to ensure the safety of the individuals and success of the operation. Many localization methods such as GPS, RSSI based inertial navigation; CCTV's have been implemented to cope with crowd volumes. However, they remain ineffective for large crowd localization. The low resolution, drops in signal strength, infrastructure and operational costs are problems, and however the major hindrance in scaling these technologies for hundreds of thousands is the computational complexity and energy usage associated with these technologies. Our approach employs a variable resolution filter that allows for application governed or user defined resolution, thus decreasing the computational complexity and energy usage significantly. This would allow for long periods of operation while providing reliable localization information. Moreover, this algorithm will serve as a foundation for many localization, crowd control and context aware applications. We have evaluated our approach experimentally for both indoor and outdoor settings. The error accumulated was within acceptable ranges.

SIGNIFICANCE

Traditionally, crowd control involves use of signs to direct the individuals and strategically placed personnel. This worked well with moderate to small crowds where the support personnel were limited and thus, could communicate efficiently. Todays, crowd monitoring is spearheaded by the GPS technology. However, the 3G network that GPS depends on is highly congested in areas of high crowd densities [1]. Just under ten thousand people can lead to packet delay times ranging from 5 to 10 minutes. Moreover, the constant use of GPS drains the battery inhibiting long term usage [2][3][4]. These make GPS unreliable for long term real time applications. What we need to realize and act upon is the tremendous increase in crowd volumes over the past decade. With over a 8 million pilgrims gathered at the banks of river Sarasvati for the Kumbh[5] festival in India or the hundreds of thousands at the Hajj grounds in Mecca at any time, the application of GPS or other such network dependent technologies is not feasible. Scaling the stationed personnel with crowd volume becomes highly inefficient with large crowds. It is not possible to create efficient communication channels for the large number of stationed personnel to interact with each other to create a real time picture of the crowd flow. As a result there is a significant time lag before circumstances such as a stampede are detected. It's even harder to identify problems that may arise on a smaller scale such as an injured individual separated from his group.

FORWARD THINKING/INNOVATION

The crowd flow monitoring and optimization are dependent on a reliable inertial navigation system. The smartphone based inertial navigation system we have developed is cost effective, reliable and scalable. The computations are performed leveraging sensor data from the phone without the need for a cellular data network. The crowd flow optimization module will use this technology to provide real-time crowd density and flow data. Secondly, we will develop predictive algorithms to anticipate events such as stampedes allowing the responsible personnel to take preventative measures. Lastly, the data gathered will provide critical inputs for simulations to detect possible bottlenecks in the system and generate optimization parameters.

STUDENT INVOLVEMENT

Piyush will work on developing the crowd flow optimization algorithm and running simulations to test it. Once tested, Tanvir will begin working a smartphone implementation to gather data and monitor the results. This will provide important metrics regarding the feasibility of a smartphone implementation, such as time lag and battery usage.

REFERENCES

[1] Blanke, U.; Troster, G.; Franke, T.; Lukowicz, P., "Capturing crowd dynamics at large scale events using participatory GPS-localization," in Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2014 IEEE Ninth International Conference on , vol., no., pp.1-7, 21-24 April 2014

[2] Nawarathne, K.; Fang Zhao; Pereira, F.C.; Jun Luo, "Dead reckoning on smartphones to reduce GPS usage," in Control Automation Robotics & Vision (ICARCV), 2014 13th International Conference on , vol., no., pp.529-534, 10-12 Dec. 2014

[3] Lei Zhang; Jiangchuan Liu; Hongbo Jiang; Yong Guan, "SensTrack: Energy-Efficient Location Tracking with Smartphone Sensors," in Sensors Journal, IEEE, vol.13, no.10, pp.3775-3784, Oct. 2013

[4] Lei Zhang; Jiangchuan Liu; Hongbo Jiang, "Energyefficient location tracking with smartphones for IoT," in Sensors, 2012 IEEE , vol., no., pp.1-4, 28-31 Oct. 2012

[5] Huffington post. (2013). Top 10 crowd-drawing events from around the world. Retrieved 09/15, 2015, from http://www.huffingtonpost.com/cheapflights/top- 10-crowddrawing-event_b_3594312.html

MARQUETTE INTERNATIONAL RESEARCH POSTER SESSION

ABSTRACT

PROJECT TITLE: "**Die spacer reproduction analysis of single zirconia crown made by CAD/CAM milling technology"**

FACULTY NAME: **Seok Hwan Cho, DDS, MS, MS,**
Assistant Professor, Dept. of General Dental sciences, School of Dentistry
Guentsch, Arndt, DDS, PhD, Associate Professor, Dept. of Dental Surgical Sciences

OVERVIEW & GOALS OF THE PROJECT

In dentistry, computer-aided design (CAD) technology currently provides the ability to virtually design a wax-up and program the die spacer thickness. However, no studies have been published to date that assessed the relationship between die space setting and internal gap of milled CAD/CAM crowns. Therefore, the purpose of this study was to evaluate accuracy and precision of the die spacer thickness achieved by the combination of CAD and milling.

DESCRIPTION OF INTERNATIONAL COMPONENT

After fabricating milled zirconia crowns in US, the crown will be shipped to Germany to be digitized using a structured light scanner and saved in STL format (Otto Vision, Jena, Germany). All STL records will be superimposed via a best-fit method. A recently introduced method allows the quantitative and qualitative three-dimensional analysis of dental materials, including restorations, impressions, or casts.[1] By computing all possible orientations (Qualify 12, Geomagic GmbH), records of the crown and the reference tooth will be superimposed. With this superimposition, the milled crowns and dentoform tooth data will represent the best object-to-object penetration. Dimensional differences between both crowns to reference tooth will be computed. Therefore, the collaboration between US and Germany will provide the accurate result analysis and evaluation.

SIGNIFICANCE

The inability to control die spacer thickness has been reported in the literature. However, little information is available on the congruency between the computer aided design parameters for die spacer thickness and milling technology. This study will enable the clinician to evaluate the accuracy of the CAD/milling combination. This is crucial in understanding the limits of CAD/CAM milled crowns and its uses in producing accurate restorations.

FORWARD THINKING/INNOVATION

Some of the factors affected by the die spacer thickness are fracture strength, retention, and marginal gap.[2] In addition, die spacer has been shown to improve the marginal fit between the restoration and tooth preparation, decreasing the risk of cement dissolution, plaque accumulation, recurrent decay, and periodontal problems. However, the inability of manual methods to produce die spacer layers of defined thickness and uniformity is of great concern to dental practitioners. Thus, the new technology using computer-aided design (CAD) provides the ability to virtually design a wax-up and program the die spacer thickness. The average internal gaps obtained from CAD/milling technology have been previously investigated. However, no studies have been published to date that assessed the relationship between die space setting and internal gap of milled CAD/CAM crowns. Therefore, the primary objective of the research will be to test the accuracy of CAD/milling by comparing various measured internal gap thicknesses with the prescribed values of 25 µm, 45 µm, 65 µm, 85 µm, and 105 µm. A one-way analysis of variance (ANOVA) will be conducted to assess the overall statistical significance of differences among groups.

REFERENCES

1. Schaefer O, Watts DC, Sigusch BW, Kuepper H, Guentsch A. Marginal and internal fit of pressed lithium disilicate partial crowns in vitro: A three-dimensional analysis of accuracy and reproducibility. Dent Mater 2012;28:320-26.
2. Cho SH, Chang WG, Lim BS, Lee YK. Effect of die spacer thickness on shear bond strength of porcelain laminate veneers. J Prosthet Dent 2006;95:201-8.

INTERNATIONAL RESEARCH TO IMPROVE PLANNING, CARE AND FUNCTIONAL OUTCOMES IN CHILDREN WITH ORTHOPAEDIC DISABILITIES: MANILA, PHILIPPINES

Faculty: Gerald Harris PhD, PE; Graduate Students: Jacob Rammer, MS & Rebecca Boerigter, BS:
Biomedical Engineering Department, Marquette University

OVERVIEW/GOALS

The Orthopaedic and Rehabilitation Engineering Center (OREC) at Marquette has developed a mobility assessment system for lower and upper extremity evaluation of children with orthopaedic disabilities. The goal of the research is to improve care through objective assessment of motion during critical functional activities. The system components were developed at Marquette and validated [1,2] to provide accurate kinematic analysis of gait and upper extremity motion during daily living activities and manual wheelchair propulsion.

INTERNATIONAL COMPONENT

Over the past three years, OREC has developed an international research collaboration with colleagues at the Philippine General Hospital (PGH) in Manila, Philippines. Partners include specialists within the Departments of Orthopaedic Surgery and Rehabilitation (PM&R). OREC contributors include faculty and students from the Biomedical Engineering Department at Marquette, as well as physicians and therapists.

SIGNIFICANCE

The system supports research to improve treatment planning, follow-up and long term assessment of interventions. For example, it is currently being used in one project to evaluate the effectiveness of foot and ankle braces prescribed for children with cerebral palsy. It is being used in another research project to evaluate surgical outcomes from tendon transfers, lengthenings and osteotomies to improve gait. A third project is evaluating manual wheelchair propulsion with a goal of reducing injury risk. The system is also used for education of medical residents. Over the past 6 months, colleagues in Manila have used the system to evaluate 76 children. The overarching goal is to conduct independent research that is eventually sponsored by the Philippine Government. A notable accomplishment towards this goal was recent funding by HHS, NIDILRR for post-doctoral fellowships with optional rotations at PGH.

FORWARD THINKING/ INNOVATION

Innovative biomedical engineering support has provided the opportunity to install a validated lower cost system that is technically competitive with well supported research labs. Communication and technical support through our 'sister' lab at Marquette allows rapid responses to challenges and inclusion of our Manila colleagues on new multi-center research projects. Recent funding by HHS, NIDILRR with an optional PGH rotation brings additional resources to support these research efforts. Finally, use of the system improves clinical treatment while also supporting a culture of better education. Most recently we have been working to better understand the biomechanics of wheelchair propulsion in general, and more specifically in utility wheelchairs as used by children in Manila. These chairs lack adjustability and are candidates for redesign to reduce joint loads and ongoing complaints of upper extremity pain.

REFERENCES 1) J.D Kertis et al., *Physical and Rehabilitation Medicine*, Vol 22, 49-60 (2010), 2) J.R. Rammer et al., *Proc IEEE Eng Med Biol. Soc*, 2525-2528 (2014).

Faculty: Cristinel Ababei
Student: Shaun Duerr

Tentative Title of Project:
SmartBuilds – a distribution network and multiple buildings co-simulation framework

Abstract:
We introduce a district level multiple buildings energy and power simulation framework. At the building level, the proposed simulation framework, SmartBuilds, leverages EnergyPlus as the core simulation engine for building energy assessment. Building models may include batteries for energy storage and renewable energy generators: PV arrays and wind turbines. At the district level, one of the main goals is to provide a versatile platform for the simulation and optimization of the interaction between the electric grid and buildings as well as of the interaction between buildings. Because buildings can participate in intelligent social-like activities through which energy tokens/budgets can be exchanged, the tools provides collective optimization opportunities beyond the usual techniques applied at building level.

Faculty: Cristinel Ababei
Student: Milad Ghorbani Moghaddam

Tentative Title of Project:
Thread migration and DVFS based dynamic reliability management for chip multiprocessors

Abstract:
We investigate dynamic voltage and frequency scaling (DVFS) and thread migration as mechanisms for dynamic reliability management (DRM) of chip multiprocessors (CMPs). While the chip multiprocessor is continuously monitored and reliability is estimated in real time, the voltage and frequency of different cores in the CMP are dynamically adjusted or threads are migrated between cores such that reliability converges towards the desired target. When the temperature of cores increases and thus reliability degrades, the proposed DRM scheme throttles selectively the frequency of the cores with the highest temperature or threads are moved to cooler cores. This is turn, leads to a lower power dissipation in those cores whose temperature decreases, thereby improving reliability.

Faculty: Cristinel Ababei
Student: Nathan Zimmerman

Tentative Title of Project:
MarqDrone – developing a quadcopter from the ground up

Abstract:
The objective of this project is twofold: 1) Design from scratch and prototype a quadcopter whose continuous operation on a single battery charge is longer than what is currently available and 2) to develop algorithms for wildfire path prediction based on the realtime aerial mapping images collected by the drone. Predicting wildfire paths in realtime so that firefighters and other resources can be deployed and distributed effectively is very challenging because of the multitude of factors affecting how wildfire spreads, the lack of realtime data, and the complexity of prediction. Our goal is to provide a complete hardware/software (HW/SW) solution to this problem. While the project focuses on the wildfire path prediction problem, the proposed HW/SW platform can be used for other applications including farming and wildlife monitoring.

Name: Allison Abbott and Jordan Brown
Title: From Gut to Germ cells: Analysis of microRNA transport from the *C. elegans* intestine to oocytes.

Abstract
microRNAs (miRNAs) are 22 nucleotide noncoding RNAs that function to regulate gene expression post-transcriptionally. While they are necessary for many aspects of development and physiology in diverse organisms, the individual functions of miRNAs are largely unknown. The central question in my lab is to determine the pathways and specific targets regulated by individual miRNAs in the process of ovulation. In *C. elegans*, it has been observed that miRNAs are required for ovulation, a rhythmic process that occurs every 20 minutes in adult worms. As oocytes mature, they signal to the surrounding somatic gonad cells to drive their entry into the spermatheca and subsequent fertilization. Recent work has indicated that miRNAs are required in oocytes to control the process of ovulation. Interestingly, many of the individual miRNAs that are found in mature oocytes show strong expression patterns in the intestine. The intestine is connected to the germline because it is the source of yolk proteins, which are transported from the intestine into the oocytes through a receptor-mediated endocytosis mechanism. We hypothesize that the intestine is also a source of mature miRNAs that are imported into oocytes and then could control the process of oocyte maturation and ovulation. To test this hypothesis, we will analyze miRNAs levels in mature oocytes in wild-type worms and in mutant worms that have defects in secretion or endocytosis. In addition, we will perform in situ hybridization to determine the location of microRNAs in wild-type and mutant worms. This would advance our understanding of miRNA regulation because transport of miRNAs has not been observed in *C. elegans.*

Significance
miRNAs have been observed to be found in secretory vesicles called exosomes in other systems, including in humans. Exosomal miRNAs have been correlated with human disease progression, including cancer metastasis. The identification of exosomal transport of miRNAs in *C. elegans* would provide a tractable system to analyze this mechanism for the regulated transport of important regulatory molecules such as miRNAs. It would also allow us to identify novel regulators of this mechanism through forward genetic screens.

Funds
Funds would be used to purchase reagents to analyze microRNA levels and spatial localization using quantitative real time PCR and in situ hybridization in wild-type and mutant worms. An undergraduate student, Jordan Brown, will be supported on this project.

PROJECT TITLE: mHealth system for Patients with Arthritis

FACULTY NAME: Sheikh Iqbal Ahamed, Ph.D, Department of MSCS, Marquette University
STUDENT NAME: Taskina Fayezeen, Md Osman Gani, Department of MSCS, Marquette University

INTRODUCTION

Arthritis is one of the leading cause of disability worldwide. Arthritis patients suffer from joint disorder including inflammation. It is a chronic disease with ups and downs throughout the life time. Appropriate exercise, medication and diet can help to minimize pain and inflammation. Numerous studies show that diet has an influential role in joint inflammation. It includes processed food, sugar, dairy products, and fried food [1]. Moreover, physical activity can decrease pain. It can also improve mobility and functionality [2]. Tracking and monitoring the physical activities and diet by a proper healthcare system may improve the quality of arthritis patients' life. The use of mobile and wireless technologies is becoming very popular in the healthcare, popularly known as mHealth. mHealth has impact all over the world. Lower costs and pervasive use of mobile devices are the main reasons that make healthcare faster, better and affordable. Recent research shows that mHealth has, and will continue to have remarkable impact on the delivery of healthcare services. The mHealth system presented here will help the patients to manage their pain. The physicians will also get better insight of their patients' current health state. Based on the evaluation, physicians will be able to take better decision about the treatment of the patients. This mHealth system will act like a bridge between doctors and patients. It will help patients to track their daily activity, pain, diet and report to the physicians when needed. Automated recognition of physical activities will provide patients a better assessment of their daily outcome. We will work on the design and development of an mHealth system to manage patients' pain and improve quality of their life. The system will contain automated physical activity recognition model, continuous daily activity monitoring and reporting tool for pain and diet.

SIGNIFICANCE

Tracking and maintaining a routine life is necessary for arthritis suffering patients. Using our system, they will be able to store and evaluate their every day's medications, diet, physical activities, and pain level. The generated report from the system will be helpful to get a better insight between diet, physical activity, and pain level. It will help patients to maintain appropriate diet and physical activity to reduce the joint pain level. It will provide important information of patients to the physicians and help to provide proper treatment.

FORWARD THINKING/INNOVATION

Research on mHealth is growing fast due to its great impact on healthcare services. By paying close attention to patient interests and specific disease related requirements, the healthcare industry can deliver specialized mHealth tools. Our goal is to develop an android based mHealth tool for arthritis patients. The tool will be designed to collect different types of information from the patients. It will offer four modules 1) *collect pain and dietary information*, 2) *automated activity recognition*, 3) *text notification* and 4) generate *report*. The data from manual and automated system will help patients to generate report and analyze their conditions. To our best knowledge, this is the first mHealth system to address health outcomes of patient with arthritis.

STUDENT INVOLVEMENT

Taskina will work on the design and development of the mHealth system. Osman will work on the automated activity recognition module.

REFERENCES

[1] J Kjeldsen-Kragh, C.F Borchgrevink, E Laerum, M Haugen, M Eek, O Frre, P Mowinkel, K Hovi, Controlled trial of fasting and one-year vegetarian diet in rheumatoid arthritis, The Lancet, Volume 338, Issue 8772, 12 October 1991, Pages 899-902, ISSN 0140-6736.
[2] Margaret Shih, Jennifer M. Hootman, Judy Kruger, Charles G. Helmick, Physical Activity in Men and Women with Arthritis: National Health Interview Survey, 2002, American Journal of Preventive Medicine, Volume 30, Issue 5, May 2006, Pages 385-393, ISSN 0749-3797.

PROJECT TITLE:

Gait Detection on Unconstrained Smartphone Using a Wireless Smart-shoe Systems

FACULTY NAME: Sheikh Iqbal Ahamed, Ph.D.

STUDENT NAME:

AKM Jahangir Alam Majumder, Computational Sciences Doctoral Student.

INTRODUCTION

Injuries due to gait abnormality are a major health problem all over the world [1]. These injuries are associated with significant mortality, disability, and decreased quality of life. Analysis of the human gait for predicting fall related injuries is the subject of many current research projects. Accurate reliable knowledge of one's gait characteristics at a given time, and even more importantly, monitoring and evaluating them over time, will enable early diagnosis of abnormality in gait. This diagnosis will also help to predict and prevent an injury. By 2050, it is estimated that more than one in five people will be age 65 or over. Falls in the elderly are very common occurrences as approximately one-third to one-half of the population repeatedly experience falls on a yearly basis. So, the automatic detection of injuries would help reduce the time of arrival of a medical caregiver, and accordingly decrease the mortality rate [2]. Several clinical studies have demonstrated that most injuries related to falls are affected by gait parameters. All parameters are subject dependent, varying with gender, race, ethnicity and age. Therefore, risk to health in falls differs widely from individual to individual. The gait parameters take effect at different scale levels and affect different physical injuries. To address the above-mentioned challenges, we propose a smartphone-based gait detection system named "Your Walk is My Command." This system can warn the user by generating an alert message in their smartphone to prevent this type of unforeseen fall due to gait abnormality. It also triggers a vibrating alert to notify the user to prevent them from a forthcoming injury.

SIGNIFICANCE

Risk identification using gait patterns with embedded smart-shoe sensors has been the subject of much study over the past decade. Most of the earlier approaches regarding gait recognition utilize accelerometers attached to the subject for gathering data. Gait and balance disorders are common in older adults and are a major cause of injuries in this population. Scientific research on smartphone-based gait detection system has recently been stimulated due to the growing elderly population and their risk of injuries. In all previous studies, the system can detect any fall related injury only after it has already occurred and the system sends an alarm to the caregivers for immediate help. We believe that the best way to reduce the number of injuries is to alert the users about their abnormal gait/walking. If abnormal walking patterns can be identified using automated processes and with good accuracy, the elderly can be saved from a potential fall related injury. According to our research, we are the first to propose a gait assistance system that detects users' abnormal gait patterns by monitoring the user' daily activity to alert them regarding a possible injury.

FORWARD THINKING/INNOVATION

The proposed smartphone-based gait assistance approach for detecting and predicting abnormal gait 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 smart-shoe, it also gains the benefits of mobility and direct internet connectivity while being relatively inexpensive and non-invasive. Dr. Ahamed plans to evaluate the system for nursing home patients who have chronic gait problems. Jahangir will use the information gained from this experiment to develop a novel gait assistance system and will present it 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 biomechanical model of gait events. He will also implement the model in the smartphone for risk assessment by analyzing the gyroscope and accelerometer data from smartphone and data from the smart-shoe. Using the system Jahangir will also assess the effects of balance abnormality on human walking patterns and the variability of the extracted features.

REFERENCES

[1] H. Yu, M. Alaqtash, E. Spier, and T. Sarkodie- Gyan, "Analysis of muscle activity during gait cycle using fuzzy rule-based reasoning", Journal of Measurement, Vol. 43, pp. 1106-1114, 2010.

[2] J. Majumder, S. I. Ahamed, R. J. Povinelli, C. P. Tamma, R. O. Smith, *"A Novel Wireless System to Monitor Gait Using Smartshoe-Worn Sensors"*, in Proc. of the IEEE Computer Software and Applications Conference (COMPSAC 2015), Taichung, Taiwan, July 2015.

PROJECT TITLE : Personalized mobile based learning tool for pregnant women regarding premature baby.

FACULTY NAME : Sheikh Iqbal Ahamed, Ph.D, Mir Abdul Basir, MD and Una Olivia Kim, MD

STUDENTS NAME: Md Kamrul Hasan, Golam Mushih Tanimul Ahsan, Computational Sciences Doctoral Student.

INTRODUCTION: In an average week in Wisconsin, about 135 infants are born premature. In the event of a preterm delivery parents are expected to immediately participate in complex and critical decision-making such as whether to resuscitate their extremely premature infant or not. Effective participation in such decisions requires parental knowledge of potential health outcomes of their premature child. Currently, neonatal outcome information is not being discussed during routine prenatal care with parents with risk factors for preterm delivery. This leaves them unprepared and negatively impacts informed decision-making, should the event arise. Use of mobile health, which refers to use of mobile technology to deliver health information, is a novel tool to address healthcare challenges. The ***goal of this proposal*** is to develop a smartphone-based mobile application (app) for parents at risk for premature delivery. We anticipate this innovative tool will provide significantly enhanced educational materials and promote better parental understanding and participation in decision-making in the event of a premature birth.

SIGNIFICANCE: Premature births are a national public health problem. A full-term birth is defined as 40 weeks' gestation and a premature birth is before 37 weeks. Most infants born before 34 weeks of gestation require intensive care. In 2005, the national cost of prematurity was $26 billion. Despite intensive care, all premature infants do not survive and those who survive are at risk for chronic health problems, physical disabilities, cognitive compromise, hearing impairments, vision impairments, learning problems and behavioral issues. Another concern is the significant racial and socioeconomic disparities associated with preterm births. African-American women have the highest rate of premature births: they deliver before 37 weeks twice as often as other races and before 32 weeks three times as often as Caucasian women.

FORWARD THINKING/INNOVATION: *The proposed intervention will change where, when and how parents at risk of premature delivery receive relevant prenatal education.* Prenatal care is defined as "exchange of information and identification of existing risk factors that may impact the pregnancy." Good prenatal care optimizes pregnancy outcomes. Patient education is an important aspect of prenatal care.[16] Lack of trained providers to give accurate and reliable neonatal outcome information during prenatal care is a limiting factor.[5] The proposed educational tool will help overcome these barriers to meet the need.

STUDENT INVOLVEMENT: Md Kamrul Hasan and Golam Mushih Tanimul Ahsan are working on the mobile application design and development for both android and iOS version of mobile phone devices. Dr Basir and Dr Kim Olivia, neonatologist of MCW in WI, are also collaborating with us for content of the mobile application. In the app, the users' responses to the application information are recorded and saved in database for better assessment. We anticipate that our app users will go through all the information pages and will spend more time on it to learn different unknown items.

PROJECT TITLE:

Efficient Patient Behavior Prediction by Incorporating Human Factors in IoT-based Mental Health-care Systems

FACULTY NAME:

Sheikh Iqbal Ahamed, Ph.D.,Marquette University, and Zeno Franco, PhD, Medical College of Wisconsin

STUDENT NAME:

Do Duc, Johnson Nadiyah, Zhou Wu, Xuyong Yu, Marquette University

INTRODUCTION

Mental health problems can cover a broad range of disorders, but the common characteristic is that they all affect the affected person's personality, thought processes or social interactions. A particularly large proportion of veterans returning from overseas are affected by mental health problems, a symptom named Post Traumatic Stress Disorder (PTSD) impacts between 15-20% of military veterans. PTSD significantly increases the propensity to engage high risk behaviors, including alcohol, substance abuse, impulsivity, and angry outbursts. These behaviors raise a veteran's risk for interpersonal violence, suicide and unintentional injury to themselves and others [4]. Nationally, serious mental health problems results in $317B in annual healthcare expenditures, lost productivity, and disability benefit payments. Mental health problems are correlated with cardiovascular disease, diabetes and early mortality.

SIGNIFICANCE

In attempting to detect early warning signs that indicate an angry outburst from a veteran is immanent, classic problems that degrade crisis prediction come to the fore. There are also significant costs associated with either false positives or false negatives in this setting. First, while crisis theory suggests that there are discrete early warning signs, it is not easy to meaningfully demarcate the distinctions between what we term here "micro-behavior" indicators and "macro-behaviors" and outcomes from the perspective of behavioral science research, mental health clinicians, or using a computational view. Second, once these behaviors can be sufficiently defined, the IoT system has to be able to be able to reliably identify these behaviors in real-world settings and in real time against a backdrop of noise. This is not straightforward even using traditional social science approaches, given that patients suffering from mental health problems often under-report or deny behavioral events on the one hand, and also engage in many behaviors that might resemble, but are not actual rage on the other. These problems make obtaining accurate training data difficult. Third, once the behaviors are defined and can reliably parsed from sensor data, developing predictive models that account for social context and individual variability in patients' personal triggers and thresholds for rage offers another substantial hurdle.

FORWARD THINKING/INNOVATION

A major innovation in our proposed approach to predicting patient behavior is to detect complex emotions and abnormal behaviors through probabilistic planning techniques, so that the results can be used to develop a personalized risk model for the patient. The personalized risk model will integrate data from multiple devices in IoT environments and use real-time data aggregation and multimodal data analytics for patient behavior prediction. Another major innovation in our approach is the proposed adaptive security protocol which will not just be used for maintaining data confidentiality, but also ensuring the accuracy and integrity of patients' health data, which are essential for achieving accurate patient behavior predictions. Our approach will be tested in real-world settings with high-risk veterans through an existing community-academic partnership for veteran health with demonstrated ability to recruit veterans to participate in the proposed project.

REFERENCES

[1] Gahm, G. A., & Reger, M. A. (2015). Suicide risk among 1.3 million veterans who were on active duty during the Iraq and Afghanistan wars. Annals of epidemiology, 25(2), 96-100.

PROJECT TITLE

Monitoring Learning Capability in Autistic Populations using Sensors

FACULTY NAME

Dr. Sheikh Iqbal Ahmed, Dr. Amy Van Hecke, Dr. Niharika Jain

STUDENT NAME

Piyush Saxena, Computational Sciences Graduate Student

INTRODUCTION

There has been a tremendous increase in the population affected by Autism Spectrum Disorder (ASD). According to a study from CDC the number of children affected ASD went up from 1 in 150 to about 1 in 68 from within the first decade of the 20th century [1]. If the trend continues, we could have as many as 1 child in every 40 affected by ASD. While there is a lot of research being conducted today to identify causes of Autism and even cure it, we do not have a solution at this point. Soon the number of the individuals affected by ASD would reach a point where it will have a significant socio-economic impact on the country.

The PEERS intervention study at Marquette aims to understand how teenagers with autism spectrum disorder and their parents are affected by social skills therapy, the Program for the Enrichment and Education of Relational Skills, or PEERS [2]. PEERS is an evidence-based, manualized, 14-week, outpatient treatment program developed at the University of California at Los Angeles. Dr. Amy Van Hecke is certified by UCLA to provide the PEERS program at Marquette University. PEERS study groups begin every January and August, and are provided at no charge to research participants. Dr. Sheikh Iqbal Ahmed is the director of the Ubicomp Lab at Marquette University specializing in mobile health and pervasive computing.

We have collected skin conductivity (EDA) data from fourteen subjects during the PEERS intervention. The EDA is a measure of anxiety in the individual which relates to their learning capability. We are able to study the weekly impact of the intervention on the individuals. Our goal is to be able to predict the progress on an individual with only a few sessions of data.

SIGNIFICANCE

The projects is of critical importance. We are able to teach young ASD affected children to interact in society and learn. This provides them the opportunity to be functional and contributing members of the society. This has tremendous socio-economic impacts. The individuals that would otherwise have difficulty in our society would now be able to interact with others. Moreover, they can become members that contribute to the economy.

FORWARD THINKING/INNOVATION

This is a unique interdisciplinary project that that is a collaboration between social sciences and computer science. We are able to capture data (mathematics and computer science) that allows us to predict an outcome within social science.

STUDENT INVOLVEMENT

Piyush will be analyzing the collected data from 3 subjects to prepare individualized prediction models. The models will be tested on the remaining data set. The goal will be decrease the amount of data (weeks) needed to make the prediction.

REFERENCES

[1] http://www.cdc.gov/ncbddd/autism/data.html

[2] http://www.marquette.edu/psyc/about_PEERS.shtml

PROJECT TITLE Context-aware Complex Activity Recognition
FACULTY NAME: Sheikh Iqbal Ahamed, PhD; Roger O Smith, PhD
STUDENT NAMES: Md Osman Gani, Taskina Fayezeen

INTRODUCTION

Automated recognition of the human activities has importance across different fields such as pervasive computing, artificial intelligence, human computer interaction, human robot interaction, rehabilitation engineering, assistive technology, health outcomes, social networking, and social sciences [1]. Human activity recognition (HAR) is an interdisciplinary research area which has been active for more than a decade. Despite the time length, still there are many major issues need to be addressed [2]. This would provide a significant improvement in different aspect of the applications of the HAR in different fields. There are numerous context-aware applications where users' activity plays a very important role. It also plays the pivotal role in pervasive computing systems. Human performs numerous activities throughout the day. There are two classes of activities based on body motion and functionality. The first one, simple full body motor activity and the second one, complex functional activity. The class, full body motor activity, considers body motion and posture, for example: walking, sitting, running. While the functional activity class deals with different function performed by user, for example: reading, working on computer, watching TV. There has been substantial research conducted on the simple human activity recognition. Whereas, few research has been conducted on the complex human activity recognition. However, there are many key aspects (recognition accuracy, computational cost, energy consumption, privacy, mobility, etc.) needed to be addressed in both areas to improve their viability. This research focuses on development of a novel complex functional activity recognition system and its evaluation in different applications. The time, location, and simple full body motor activity have been used to predict complex functional activity.

SIGNIFICANCE

Human activity recognition is an important area of research because it can be used in different context-aware applications. Humans can easily distinguish activities by observing them, but creating an automatic system to identify a particular activity from a large set of human activities is a challenging task. 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. These disruptions in routine are often used as signals for those suffering psychological impairments, such as depression and dementia.

FORWARD THINKING/INNOVATION

There has been extensive research on automated machine recognition of human activities. Most of the work has focused on recognition of simple human activities. There has been some research on complex activity. However, there are still many important issues needed to be addressed including recognition accuracy and practical usability. In this research, we are proposing a novel system to predict complex activity based on time, user location and simple human activity. Simple activities provide influential information about complex activities. This is the first approach which considers the simple activity as a parameter to predict the complex activity. Incorporation of this vital parameter in the recognition system will improve the performance of the system.

STUDENT INVOLVEMENT

Md Osman Gani, a doctoral student of MSCS department, has been working on his dissertation which focus on developing context-aware complex activity recognition system. He has developed localization system using wireless signal and simple activity recognition system using smartphone sensors. These two systems will be used to build the proposed system.

REFERENCES

[1] L. C. Jatob´a et al., "Context-aware mobile health monitoring: evaluation of different pattern recognition methods for classification of physical activity." IEEE Engineering in Medicine and Biology Society, pp. 5250–3, 2008.
[2] O. D. Lara and M. a. Labrador, "A Survey on Human Activity Recognition using Wearable Sensors," *IEEE Communications Surveys & Tutorials*, vol. 15, no. 3, pp. 1192–1209, 2013.

Thermodynamically-Constrained Computational Model of Lung Mitochondrial Bioenergetics

Xiao Zhang[1], R.K. Dash[2], V.R. Pannala[2], A.V. Clough, E.R. Jacobs, S.H. Audi[1]

[1]Department of Biomedical Engineering, [2]Department of Physiology, Medical College of Wisconsin

Introduction: Acute lung injury (ALI), characterized by rapidly progressing hypoxic lung failure, is one of the most frequent causes of admission to medical intensive care units [1]. Studies have suggested that mitochondrial dysfunction plays a key role in the pathogenesis of ALI [2]. Thus, the objective of this study is to develop and validate a thermodynamically-constrained computational model of lung mitochondrial bioenergetics.

Materials and Methods: The model consists of three regions: extra-mitochondria, mitochondrial matrix, and inter-membrane space. The model accounts for major mitochondrial transport and reaction pathways such as pyruvate-hydrogen co-transporter, inorganic phosphate carrier, ADP/ATP exchange via the adenine nucleotide translocase, pyruvate oxidation, Krebs cycle, and electron transport chain. The model reactions are considered reversible, with the forward rate and reverse rate for each reaction constrained by the Haldane relationship [3, 4]. The governing differential equations describing the dynamic changes in the concentrations of various species were integrated using the MATLAB function ODE15s (MathWorks Inc).

Intrinsic model parameters including the reaction equilibrium constants were fixed to values from literature [4]. Other model parameters were determined using flux balance analysis subject to steady-state boundary constraints from previously published isolated mitochondria data [4]. To validate the model, we measured O_2 consumption in rat lung mitochondrial-enriched fraction following the addition of succinate (SUC, 7 mM) or malate (MAL, 5 mM) + glutamate (GLU, 10 mM) in the absence (state 4) and/or presence of ADP (0.2 mM, state 3), uncoupler (CCCP, 5 μM; uncoupled state 3) or complex IV inhibitor potassium cyanide (KCN, 2 mM).

Results and Discussion: Figure shows representative O_2 consumption data in rat lung mitochondria following the addition of malate plus glutamate in the absence and presence of various metabolic inhibitors. The addition of ADP (state 3) or a mitochondrial uncoupler (uncoupled state 3) stimulated O_2 consumption, whereas the addition of potassium cyanide (state 5) almost completely inhibited O_2 consumption. The state 2, state 3, and uncoupled state 3 O_2 consumption rates with SUC as substrate were higher than those with MAL + GLU as substrates. The tissue respiratory control index (RCI), the ratio of state 3 to state 4 O_2 consumption rate, is a measure of the tightness of coupling between mitochondrial respiration and phosphorylation and hence an index of mitochondrial membrane potential. RCI was higher (unpaired t-test, $p < 0.05$) with MAL + GLU (2.58 ± 0.06 SEM, n = 4) as substrates than with SUC (1.64 ± 0.02, n = 4).

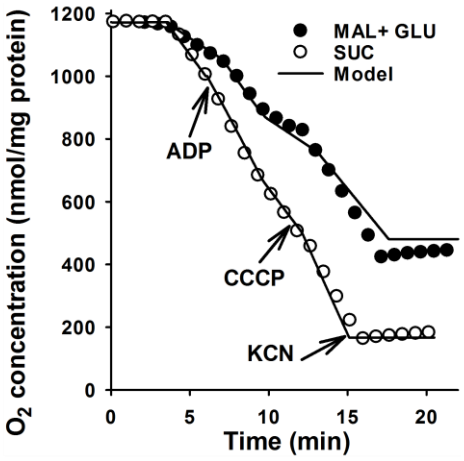

Figure shows the consistency between the O_2 consumption data and model solutions for the NADH- and $FADH_2$-linked substrates with otherwise the same values of model parameters. Further validation of the model will be an iterative process where more experimental data will provide a basis for refining the model, then using the model to predict the response of the system to perturbations that are experimentally testable, at various levels of biological complexity.

Conclusions: We have developed and validated a thermodynamically-constrained computational model of lung mitochondrial bioenergetics. To the best of our knowledge, this model is the first for lung tissue mitochondrial bioenergetics. The model will provide a mechanistic and quantitative framework for assessing the impact of a change in one or more mitochondrial processes on overall mitochondrial bioenergetics, and will be an important step towards the development and validation of a comprehensive thermodynamically-constrained computational model of isolated perfused rat lung tissue bioenergetics. The latter will allow us to evaluate the impact of ALI-induced changes in one or more mitochondrial or cytosolic processes on overall lung tissue bioenergetics, and for assessing the impact of targeting specific processes for mitigating the impact of ALI on lung tissue bioenergetics.

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References:

[1] J.E. Levitt, M.A. Matthay, *Crit. Care* 16:223-234, 2012.

[2] R.D. Bongard, K. Yan, R.G. Hoffmann, S.H. Audi, X. Zhang, *Free Radical Bio. Med.* 65:1455-1463, 2013.

[3] R.K. Dash, Y. Li, J. Kim, G. Saidel, M.E. Cabrera, *IEEE Trans Biomed Eng.* 55(4):1298-1318, 2008.

[4] F. Wu, Y. Feng. C.V. Kalian. *J Biol Chem*, 282: 24525-24537, 2007.

TITLE: "Escalation: Raising the college students' awareness of warning signs of abusive relationships"
FACULTY NAME: Abir K. Bekhet, PhD, RN, H.S.M.I. Associate Professor, College of Nursing
STUDENT NAME: Alina Atayan, Undergraduate Nursing Student

INTRODUCTION

Abusive relationships are highly prevalent in our society. Statistics show that 1 in 3 women and 1 in 4 men will be in a violent relationship in their lifetime. According to the CDC, the highest risk group for this violence is those aged 18-24 years old. [1, 2] Relationship violence is defined as a pattern of behavior in an intimate relationship that is used to establish power and control over another person through fear and intimidation[3]. This includes: dating violence, domestic violence, or relationship violence. Victims of relationship violence tend to stay in the relationship for a long period of time because, in most circumstances, they are unaware of the abusive relationship until they are physically harmed. [3] Even at that point, many people stay with their abusive partner because they are scared of the consequences of leaving them, worry about what their friends and family would think, feel that there is no one to turn to, or believe it is their faults. [2] 57% of college students reported having difficulty in identifying relationship violence, while 58% reported not knowing what to do to help someone who is dealing with relationship violence. Educating college students through peer facilitated group discussions is essential in raising the college students' awareness of the warning signs of abusive relationships to prevent its harmful consequences.

SIGNIFICANCE

Given the higher prevalence of abusive relationship in our society and the lack of awareness about the early signs of abusive relationships among college students, preventative measures need to be taken to help raising the college students' awareness of warning signs of abusive relationships. In fact, educating this high risk group will have a positive outcome in terms of preventing the physical, emotional, and the mental consequences of the abusive relationships as well as saving many of the lives of those who get abused.

FORWARD THINKING/INNOVATION

This study is innovative as it focuses on raising the college students 'awareness of warning signs of domestic violence. Since we will be educating students about a spectrum of warning signs, they will be able to identify an abusive relationship during different stages. By raising awareness about relationship violence as well as their early signs, students will feel empowered. Many times people will disconcert signs of potential abuse until it is too late and they or a loved one are being physically harmed. By providing them with this education we are helping in preventing domestic violence as it will help diffuse the relationship before it escalates to a point of physical abuse. Our study also helps two groups of people, victims and bystanders. This is important as these groups will connect in real life. By educating those who may be potential victims, we are helping to empower them and by educating bystanders we are helping this group make a difference in the life of a potential victim. Many times victims feel alone and that they cannot reach out to a friend about the matter. By educating both groups, we are creating a cohesive community of students, who are well educated, understand the domestic violence, and know how to diffuse it in a safe manner for all parties, thus illuminating domestic violence and stopping it before it begins.

STUDENT INVOLVEMENT

Alina Atayan will take the lead on this project with the support of and collaboration with Dr. Bekhet. They will recruit three focus group participants (n=45), develop the focus group questions, and lead the 90 minute "Escalation" workshop. The workshop was developed by the One Love Foundation. A pre and post survey will be given to collect qualitative data regarding the effectiveness of the workshop in identifying the warning signs and possible interventions. This data will be analyzed by both Dr. Bekhet and Atayan. The information will help determine how to further enact preventative education regarding relationship violence. Dr. Bekhet and Ms. Atayan both received training sessions by the One Love Foundation. One Love Foundation was created in 2010 to honor the memory of their daughter, Yeardley Love, a senior at the University of Virginia, who was beaten to death by her ex-boyfriend weeks short of graduation.

REFERENCES

1.Black, M.C., Basile, K.C., Breiding, M.J., Smith, S.G., Walters, M.L., Merrick, M.T., Chen, J., & Stevens, M.R. (2011). The National Intimate Partner and Sexual Violence Survey (NISVS): 2010 Summary Report. Atlanta, GA: National Center for Injury Prevention, Centers for Disease Control and Prevention.
2.Dating and Relationship Violence. (2015). Retrieved October 19, 2015, from http://www.cmhc.utexas.edu/vav/vav_relationshipviolence.html
3. Defining Relationship Violence. (2010). Retrieved October 23, 2015, from http://www.joinonelove.org/define_10_signs

PROJECT TITLE: "Psychometrics of the Positive Thinking Skills Scale in Dementia Caregivers"
FACULTY NAME: Abir K. Bekhet, PhD, RN, H.S.M.I. Assistant Professor, Nursing
STUDENT NAME: Karie R. kobiske, MSN, BSN, RN; Denise Matel-Anderson, MSN, RN, CCRN;

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. Denise and Karie will use the information gained from this study to build on their PhD dissertations as they are interested in positive thinking, resilience, and mental health. Denise and Karie are currently PhD students at Marquette and Dr. Bekhet is their advisor. This study will facilitate further research of the students and faculty.

STUDENT INVOLVEMENT

Denise and Karie 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, Ms. Matel-Anderson, and Ms. kobiske will clean the data and analyze the results. Denise Matel-Anderson plans to study resilience (risk and protective factors) in adolescents who survived a suicide attempt. Karie R. kobiske plans to study dementia caregivers and resilience for her dissertation. This study will open avenues and thoughts for their dissertations in terms of understanding ***the positive thinking as a protective factor*** for the resilience concept. The information gained from this study will help them to develop proposals that integrate some of the resilience enhancing factors and use them as intervening variables to help caregivers and adolescents rise above their challenges and become resilient.

REFERENCES

1. Alzheimer's Association. (2013). 2013 Alzheimer's disease facts and figures. Alzheimer's & Dementia, 9(2). Retrieved from http://www.alz.org/downloads/facts_figures_2013.pdf
2. Flynn Longmire, C. V., & Knight, B. G. (2010). Confirmatory factor analysis of the Center for Epidemiologic Studies-Depression Scale in black and white dementia caregivers. *Aging & Mental Health, 14*(8), 962–970.
3. Bekhet, A. (June, 2013). Effects of Positive Cognitions and Resourcefulness on Caregiver Burden among Caregivers of Persons with Dementia. *International Journal of Mental Health Nursing, 22*, 340–346
4. Appold, K. (2009). Overcoming challenges: The power of positive thinking. American Medical Technologists Events, 72-73, 108. Retrieved from HighBeam Research: http://www.highbeam.com/doc/1G1-229543473.html
5. Bekhet, A. & Zauszniewski, J. (2013). Measuring Use of Positive Thinking Skills Scale: Psychometric testing of a new scale. *Western Journal of Nursing Research, 35* (8), 1074 - 1093.

PROJECT TITLE: "Pre-death Grief, Resourcefulness, and Positive Thinking among Caregivers of Partners with Young Onset Dementia".

FACULTY NAME: Abir K. Bekhet, PhD, RN, H.S.M.I. Associate Professor, Nursing
STUDENT NAME: Karie Ruekert Kobiske, MSN, BSN, RN;

INTRODUCTION

Young onset dementia (YOD) is the diagnosis of dementia prior to the age of 65 which impacts caregivers differently than traditional dementia. Caring for a partner diagnosed with YOD involves loss of a job, financial loss, loss of companionship, personal loss, social loss, relational deprivation and ambiguous loss that occurs when the life partner is physically present but not able to be part of the dynamic psychosocial relationship.[1,2] This loss is operationalized as caregiver grief. Caregiver grief is defined as psychosocial responses to valued loss. This grief is modified to include pre-death grief which describes the phenomena family members experienced as they watched the social and intellectual death of their loved one due to dementia.[3] Resilience theory, proposes resilience as a dynamic process of balancing risk and protective factors in the face of adversity, offers insight into why some caregivers adapt to adversity while others struggle. Pre-death grief is a risk factor that hinders caregiver well-being. This study will look for the mediating/moderating effects of protective factors namely positive thinking and resourcefulness on the relationship between pre-death grief and caregiver's well-being.

SIGNIFICANCE

Over 250,000 people in the United States are diagnosed with YOD.[4] Previous research has shown a positive outcomes on psychological well-being for traditional dementia caregivers who are resilient. To date, no research has been done to investigate the mediating/moderating effects of positive thinking and resourcefulness on the relationship between pre-death grief and psychological well-being among YOD caregivers as proposed in this study. Caregiver well-being is negatively impacted by pre-death grief as the ever-increasing caregiving demands place these caregivers at risk for long term mental and physical detrimental health consequences including possible premature death.[5] These caregivers of partners diagnosed with YOD experience a multiple losses including personal, social, financial, companionship, and intimacy.[1,2] Pre-death grief experienced by caregivers of partners diagnosed with dementia has been shown to be different from depression and be associated with higher mental health morbidity and a decreased psychological well-being.[3,6] Understanding the pre-death grief experience of caregivers of partners diagnosed with YOD in relation to positive thinking and resourcefulness will enable the development of interventions and services with a goal of decreasing caregiver morbidity and mortality and increasing psychological well-being. The ultimate goal of this study is develop further studies that will serve to decrease the caregivers' burden and to enhance their well-being, which will have an impact on their care-recipient (persons with YOD).

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the unique challenges that caregivers of a partner diagnosed with YOD face that hinder their well-being. The impact of pre-death grief has not been studied in relation to positive thinking, resourcefulness, and well-being in caregivers of partners with YOD. Karie will use the information gained from this study for her PhD dissertation as she is interested in pre-death grief and caregiver well-being. Karie is currently a PhD student at Marquette University College of Nursing and Dr. Bekhet is her advisor.

STUDENT INVOLVEMENT

This study will be a cross sectional, mixed method, descriptive study to examine the association between pre-death grief, resourcefulness and positive cognitions on caregiver well-being. Karie will recruit subjects, establish an online survey for caregivers, collect the data, and analyze the results under the direction of her advisor, Dr. Bekhet.

REFERENCES

1. Rosenthal Gelman, C., & Greer, C. (2011). Young children in early-onset Alzheimer's disease families: Research gaps and emerging service needs. *The American Journal of Alzheimer's Disease and other Dementias,* 26(1), 29-35, doi: 10.1177/1533317510391241.

2. Svanberg, E., Stott, J., & Spector, A. (2010). 'Just helping': Children living with a parent with young onset dementia. *Aging and Mental Health*, 14(6), 741-750, doi: 10.1080/1360786100371374.

3. Meuser, T., Marwit, S. & Sanders, S. (2004). Assessing grief in family caregivers. In: Doka KJ (eds). *Living with Grief: Alzheimer's disease.* Washington DC: Hospice Foundation of America, 169-198.

4. Alzheimer's Association. (2014). *2014 Alzheimer's disease facts and figures.* www.alz.org.

5. Paun, O., Farran, C.J., Fogg, L., Loukissa, D., Thomas, P.E., & Hoyem, R. (2015). A chronic grief intervention for dementia family caregivers in long-term care. *Western Journal of Nursing Research,* 37(1) 6-27. doi: 10.1177/0193945914521040.

6. Wachol-Biedermann, K., Mojs, E., Gregersen, R., Maibom, K., Millan-Calenti, J. C., &Madeda, A. (2014). What causes grief in dementia caregivers? *Achieves of Gerontology and Geriatrics,* 59, 462-467. doi: 10.1016/j.achger.2014.05.013.

INTRODUCTION

While death from other causes has decreased, the increasing number of deaths by suicide for adolescents has become a national tragedy (Fitzpatrick, 2015). Deaths by suicide have become the second leading cause of death for youth in America today (American Foundation for Suicide Prevention, 2015; CDC, 2015). Resilience theory, which proposes that resilience, is the interplay between risk and protective factors in the face of adversity will provide the theoretical framework for this study. Low self-esteem is conceptualized as a risk factor in this study and it is defined as "competence, value, and worthiness of respect" (Modrcin-Talbott, Pullen, Ehrenberger, Zandstra & Muenchen, 1998). Protective factors can enhance resilience by reducing the effects of the risk factors and minimizing negative reactions, thereby contributing to the adolescents' resiliency and positive outcomes. The protective factors to be examined in this study are perceived social support and positive thinking. Perceived social support is the individuals' perception of the persons in their life that are available, provide advice and assistance when needed. Positive thinking is defined as specific positive thinking patterns that enhance mental health and increase one's ability to effectively manage daily activities. Previous research showed that resilience promotes healthy development, emotional protection, and prevention of mental illness (Larson & Dearmount, 2002; Wallace, 2012) during adolescence. However, to date no research has been done to investigate the mediating/moderating effects of perceived social support and positive thinking on the relationship between self-esteem and resiliency among inpatient Adolescents as proposed in this study.

SIGNIFICANCE

Adolescents have been defined as a vulnerable population throughout the literature Adolescents were found to have, different risk and protective factors than other age groups (Olsson, Bond, Burns, Vella-Brodrick, & Sawyer, 2003). Resilience promotes healthy development, emotional protection (Larson & Dearmount, 2002), and prevention of mental illness (Wallace, 2012) during the years of adolescence. Understanding adolescent resiliency in relation to perceived social support and positive thinking, as proposed in this study, will enable the development of interventions and services with the goal of decreasing adolescents' suicidal attempted and mortality and increasing their psychological well-being.

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the vulnerability of the adolescents' admitted to an inpatient unit. The findings from this study will provide insights regarding the possible mediating effects of perceived social support and positive thinking on the relationship between self-esteem and lack of identity and adolescents' resiliency in inpatient adolescents. Denise will use the findings from this study for her PhD dissertation. The findings from this study will inform the creation of a suicide prevention program for adolescents. Denise is currently a PhD student at Marquette University College of Nursing and Dr. Bekhet is her advisor/chair.

STUDENT INVOLVEMENT

Denise will take the lead on this project with the support of and collaboration with Dr. Bekhet. Denise will recruit the psychiatric hospitals to obtain inpatient adolescents (n=70). Denise will obtain the IRB for the study, will collect the data, and analyze the results under the supervision of Dr. Bekhet.

REFERENCES

American Foundation for Suicide Prevention. (2015). Facts and figures. Retrieved from: http://www.afsp.org/understanding-suicide/facts-and-figures

Centers for Disease Control and Prevention (2015). Suicide trends among persons aged 10-24 years-United States, 1994-2012. Retrieved from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6408a1.htm

Fitzpatrick, J. (2015). A national tragedy: Increases in death by suicide, decreases in other major causes of death. *Archives of Psychiatric Nursing, 29*(2), 75.

Larson, N.C & Dearmont M. (2002). Strengths of farming communities in fostering resilience in children. *Child Welfare League of America, 5,* 821-835.

Luthar, S.S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development, 71*(3), 543-622.

Modrcin-Talbott, M.A., Pullen, L., Ehrenberger, H., Zandstra, K., & Muenchen, B. (1998). Self-esteem in adolescents treated in an outpatient mental health setting. *Issues in Comprehensive Pediatric Nursing, 21*, 159-171.

Wallace, E.V. (2012). Differences in mental health resiliency in young African American Americans. *American Journal of Health Studies, 27(1),* 8-12.

PROJECT TITLE: Sensory Modality Effects on Virtual Speech Learning

FACULTY MEMBERS: Jeffrey J. Berry, Ph.D., CCC-SLP, Associate Professor, Speech Pathology & Audiology,
Michael T. Johnson, Ph.D., Professor, Electrical & Computer Engineering
STUDENTS: Emily Runnoe (Undergraduate, Speech Pathology & Audiology),
James Schroeder (Undergraduate, Computer Engineering)

INTRODUCTION

The objective of this research is to investigate the speech learning process for participants with healthy and disordered speech using a virtual vocal tract (Real-time Articulatory Speech Synthesizer – RASS[1]). The RASS system uses real-time tracking of sensors attached to the tongue, lips and jaw during speech to control a software speech synthesizer that can provide both audio and visual feedback to research participants. The research will examine speech learning for talkers using different sensory feedback modalities. Prior research has demonstrated that survivors of stroke and traumatic brain injury (TBI) with severe speech impairments can learn novel articulatory patterns using audio feedback from RASS[2] and that neurologically healthy talkers show involuntary motor learning (sensorimotor adaptation)[3]. There has been no research examining the additive or independent effects of visual feedback in the speech learning process. The goal of the proposed work is to study how sensory information from different modalities affects speech motor learning in both healthy and disordered talkers.

SIGNIFICANCE

This study is clinically significant in the field of speech pathology due to its potential impact on new speech learning techniques for those with disordered speech. The intended clinical population is individuals with dysarthria, a motor speech disorder resulting from brain injury that affects the control of muscle movements during speech. We want to better understand how sensory information is used during speech relearning for survivors of brain injury and whether sensorimotor integration during speech learning differs between healthy talkers and survivors of brain injury. Our long term goal is to bolster the development of technology-based biofeedback therapies for speech neurorehabilitation.

FORWARD THINKING/ INNOVATION

Our initial work has focused on how different aspects of speech acoustics affect novel speech learning via auditory feedback. To broaden our work, we will run pilot experiments examining the effects of visual feedback, both in isolation and as an adjunct to auditory feedback. Additionally, we will incorporate more participants with dysarthria, including a larger number of survivors of stroke, in order to further extend the clinical relevance of this work.

STUDENT INVOLVEMENT

Emily Runnoe and James Schroeder will work together to further develop and execute this research study, with the support of Dr. Berry, Dr. Johnson, and other lab staff. Mr. Schroeder, with collaboration of faculty, will expand current software for experimental control and expand upon data post-processing and analysis tools[4] to expedite the dissemination of research results. Ms. Runnoe will help complete data analyses from our existing data to support manuscript and grant development. She will also help coordinate, recruit, and run participants in the proposed visual and audio-visual feedback experiments, including both healthy talkers and survivors of brain injury with dysarthria.

REFERENCES

[1] Berry, J., North, C., Meyers, B., & Johnson, M. T. (2013). Sensorimotor learning through a virtual vocal tract. *Proceedings of Meetings on Acoustics*, 19, 060099, 1-8.

[2] Berry, J., Kolb, A., North, C., & Johnson, M. T. (2014). Acoustic and kinematic characteristics of vowel production through a virtual vocal tract in dysarthria. *Proceedings of the Conference of the International Speech Communication Association (Interspeech),* pp. 1588-1592.

[3] Berry, J., North, C., & Johnson, M. T. (2014). Sensorimotor adaptation of speech using real-time articulatory resynthesis. *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP),* pp. 3196-3200.

[4] Kolb, A., Johnson, M.T., & Berry, J. (2015). Software tools and analysis methods for use with EMA data. *Proceedings of the Conference of the American Speech-Language-Hearing Association (ASHA - 2015).*

PROJECT TITLE

Scaling Factor in the RASS Speech Processing System

FACULTY NAMES

Dr. Jeffrey Berry and Dr. Michael Johnson

STUDENT NAME

Joseph Vonderhaar

INTRODUCTION

The Rehabilitative Articulator Synthesis System (RASS) is a clinical tool used in the Marquette Speech and Swallowing lab which offers human participants a way of correcting their speech. Sensors are placed in the mouth and position data is streamed into the RASS which then allows researchers to correlate lip and tongue position with different sounds. RASS provides an involuntary learning mechanism through acoustic feedback. One important aspect of the system is the scaling factor which adjusts the synthesized sound being played back to the human participant to sound more similar to the participant's real voice. The goal of this work is to develop a mechanism for automatically determining the appropriate scaling factor to use for each subject.

SIGNIFICANCE

The importance of this system is its potential impact on medical/rehabilitative applications. Many people who suffer from stroke or other severe trauma need significant speech therapy, and the RASS system is designed to provide a new mechanism for rehabilitation. The significance of the scaling factor in the system is its ability to adjust the modeled length of the vocal tract so that the sounds being played back to the human participants sound like their real voices. Participants are better able to correct their tongue and lip positions when the sounds produced by RASS are realistic.

FORWARD THINKING/INNOVATION

The innovation in this project is the development of an algorithm for a scaling factor that will much closer match the human participant than is currently implemented. By providing more realistic acoustic feedback, the rehabilitative potential of the system is improved.

STUDENT INVOLVEMENT

While RASS as a whole has evolved in recent years with previous students working on the code, the new scaling factor algorithm will be implemented by Joseph Vonderhaar.

REFERENCES

[1] Kent, R.D. "Vocal Tract Acoustics," *Journal of Voice*. Vol.7, No. 2, pp 99-117, Raven Press, LTD., New York, 1993.

[2] Maeda, Shinji. "Compensatory Articulation During Speech: Evidence from the Analysis and Synthesis of Vocal-Tract Shapes Using an Articulatory Model," France, 1989.

PROJECT TITLE:

Reduction of Interference between EGG and EMA Systems

FACULTY NAMES:

Dr. Michael Johnson
Dr. Jeffrey Berry

STUDENT NAME:

Kelly Vonderhaar

INTRODUCTION:

Electromagnetic articulation (EMA) is used to characterize speech kinematics by placing sensors on the jaws, lips, teeth, and tongue, and tracking the position and orientation of these sensors. The electroglottograph, or EGG, is used to characterize the movement of the vocal folds during speech production. This occurs by measuring the time variation of the contact of the vocal folds and analyzing this information with regards to the speech being produced. As the EMA system utilizes electromagnetic sensors and the EGG sensors contain metal, the systems are currently not used together. The purpose of this research undertaking is to analyze the feasibility of using both systems at the same time in order to obtain simultaneous speech kinematic and vocal fold information.

SIGNIFICANCE:

Being able to analyze both kinematic and vocal information for a segment of speech would be extremely useful. Although data can be taken during two trials – one using EMA and other using the EGG – there are likely to be small inconsistencies between the speech data itself, such as length, amplitude, and even in the raspy quality of the voice if the subject clears his or her throat between trials. Therefore, it is harder to show conclusive findings when trying to characterize a speech segment using two trials. Being able to use both the EGG and the EMA systems at the same time would make data collection more accurate and lead to more conclusive data.

FORWARD THINKING/INNOVATION:

This research will take place over the next 12 months. It will involve the analysis of the way that the EMA sensors perform in the electromagnetic field as well as how the EGG sensors interfere with the measurements taken by the EMA.

STUDENT INVOLVEMENT:

As a graduate student, I will be organizing and conducting all research trials. I will also be performing analysis on the data collected in order to draw conclusions about the viability of using the EGG and EMA systems together.

Bibliography:

[1] A. Kolb, "Use of an Electroglottograph to Drive an LF-Model-Based Speech Synthesizer," Milwaukee, 2014.

[2] J. J. Berry, "Accuracy of the NDI Wave Speech Research System," *Journal of Speech, Language, and Hearing Research,* vol. 54, pp. 1295-1301, 2011.

Abstract

Project Title: Interprofessional Health Team Communication about Hospital Discharge: An Evaluation Study

Faculty Names: Kathleen Bobay, PhD, RN, NEA-BC; Marianne E. Weiss, DNSc, RN

Student Names: Sarah J. Bahr, MSN, RN, ACNS-BC; Danielle Siclovan, MSN, RN, NE-BC

Introduction: Preparing patients for discharge and decreasing hospital readmissions is central to improving health care. Readmission to the hospital post-discharge is an ongoing problem for adult patients and family members and costly for health care organizations. Some readmissions are preventable and involve multiple factors, including lack of communication. Communication among providers and between providers, patients, and families is a common cause of errors. Team Rounding Process for discharge preparations targeting communication are essential for reducing readmissions.

Significance: Discharge communication is a major component in the majority of multi-modal Team Rounding Process for discharge preparations that decrease readmissions. The purpose of this study is to examine nurse, patient, and physician perceptions of the implementation of a redesigned process for discharge rounding designed by nurse and physician clinicians on the CAR study units following review of baseline data from Phases 1 and 2 of the CAR study, review of best practices literature, and AHRQ TeamSTEPPS tools.

Forward Thinking/Innovation: Team Rounding Process for discharge preparations improving communication between the healthcare team and the patient provides an opportunity to decrease hospital readmissions and healthcare costs. This qualitative evaluation study will assist in providing context for the quantitative portion of the CAR study and possible direction for future studies.

Student Involvement: Written proposal development and submission to IRB. Data collection through face to face interviews, focus groups, and observations of rounds. Constant comparison analysis of data to develop themes. Development of a manuscript in collaboration with faculty.

References:

Aston, J., Shi, E., Bullot, H., Galway, r., & Crisp, J. (2005). Qualitative evaluation of regular morning meetings aimed at improving interdisciplinary communication and patient outcomes, *International Journal of Nursing Practice, 11*: 206-213.

Center for Clinical Management Research (2013). Consolidation framework for implementation research. Retrieved from: http://cfirguide.org/

Coleman, E.A., Parry, C., Chalmers, S., & Min, S. (2006). The care transitions Team Rounding Process for discharge preparation: Results of a randomized controlled trial. *Archives of Internal Medicine, 166*(17), 1822- 1828.

Cowan, M.J., Shapiro, M., Hays, R.D., Abdelmonem, A., Vazirani, S., Ward, C.R., & Ettner, S.L. (2006). The effect of a multidisciplinary hospitalist/physician and advanced practice nurse collaboration on hospital costs. *Journal of Nursing Administration, 36*(2), 79-85.

Damchroder, L.J., Aron, D.C., Keith, R.E., Kirsch, S.R., & Alexandria, J.A. (2009). Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science . *Implementation Science, 4*(50), 1-15.

Jack, B.W., Chetty, V.K., Anthony, D., Greenwald, J.L., Sanchez, G.M., Johnson, A.E., Forsythe, S.R., O'Donnell, J.K., Passche-Orlow, J.K., Manasseh, C., Martin, S., & Culpepper, L. (2009). A reengineered hospital discharge program to decrease rehospitalization. *Annals of Internal Medicine, 150*(3), 178-187.

Kripalani, S., Theobald, C.N., Anctil, B., & Vasilevski, E.E. (2014). Reducing hospital readmission rates: Current strategies and future directions. *Annual Review of Medicine, 65*, 471-485.

Lancaster, G., Kolakowsky-Hayner, S., Kovacich, J., & Greer-Williams, N. (2015). Interdisciplinary communication and collaboration among physicians, nurses, and unlicensed assistive personnel. *Journal of Nursing Scholarship, 47*(3), 275-284.

Project Title: Reverse engineering gene regulatory networks from structural and epigenetic datasets

Faculty Name: Serdar Bozdag

Student Name: Brittany Baur

Introduction: Cancer genomes contain many structural and epigenetic abnormalities, including DNA methylation changes and copy number aberrations. DNA methylation is a chemical change to DNA, which can silence a gene's expression. Too many or too few copies of a gene can also lead to deviations from the normal levels of gene expression. One of the major challenges in computational biology is the identification of "driver" copy number changes that promote cancer cell progression [1]. These changes disrupt the normal expression levels of key regulator genes and have significant effects on downstream target genes of the regulator. As a result of altered gene expression due to these structural and epigenetic changes, cancer cells exhibit abnormalities in cell proliferation, cell migration, apoptosis and other critical pathways.

The goal of this study is to identify regulatory genes within regions with aberrant copy number and DNA methylation changes that have widespread downstream effects, and their associated targets. We will leverage copy number and DNA methylation data to infer "gene regulatory networks" which are graphical representations of interactions between genes. DNA methylation and copy number changes alter regulatory genes in a way that perturbs of the gene's expression levels and can therefore be used to computationally detect associated targets of the regulator. The aberration affects the regulator genes, which in turn affects downstream target genes. Therefore, this data would be useful in establishing directionality in the network.

Significance: Identifying aberrations in the genome that have widespread effects on regulatory genes and their associated target genes can aid in identifying therapeutic targets of cancer drugs. Certain genes with more deleterious effects on important biological pathways relevant to cancer can be prioritized as prime targets of cancer research and drug development. By utilizing a variety of biological data, we will not only be able to detect which genes are disrupted, but the cause of the disruption such as abnormalities in copy number or DNA methylation.

Forward Thinking/Innovation: Our study is an integrative approach to detecting important regulators and associated targets. By leveraging multiple types of biological data, our research takes into account different abnormalities that play an important role in cancer biology. We plan on expanding our approach to easily integrate other types of high throughput structural and epigenetic data in addition to DNA methylation and copy number data, such as miRNA expression data and histone data. Additionally, we aim to use data collected from newer technologies in our computational analysis. Finally, we aim at prioritizing likely candidate regulators within the aberration by integrating information from known biological pathways.

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

References:

[1] Sanchez-Garcia, F., Akavia, U.D., Mozes, E., Pe'er, D. 2010. JISTIC: Identification of significant targets in cancer. *BMC Bioinf.* 11, 189.

[2] Baur, B. and Bozdag, S. 2015. A canonical correlation analysis based dynamic Bayesian prior to infer gene regulatory networks from multiple types of biological data. *J. Comp. Bio.* 22(4): 289-299.

PROJECT: An alignment method to reduce mapping bias for ambiguous short reads.
FACULTY: Serdar Bozdag
STUDENT: David McKean

INTRODUCTION

Clinical diagnostic laboratories offer physicians and patients a growing set of services that rely on DNA sequencing. These genetic tests can be used to determine if a patient has inherited a greater risk for a number of diseases. Physicians also use DNA sequencing to study a patient's genome when the cause of a patient's illness is less clear[1]. During genetic testing, the laboratory equipment measures a chromosome's sequence of nucleotides and saves that data as a "sequenced read". Before the read data can be usefully interpreted, it first must be compared to a reference version of the human genome to determine this read's position on the chromosome. This process, known as alignment and mapping, is the means by which thousands or millions of reads come together to form the record of a patient's unique genetic information. In all individuals, however, there exist some regions in the genome where the DNA sequence is nearly identical to other regions in the genome. Reads from these homologous regions are often not mapped unambiguously, which means the analysis will produce lower-quality results for these regions[2,3]. We aim to reduce mapping ambiguities by improving existing alignment and mapping algorithms' sensitivity to reads from homologous regions.

SIGNIFICANCE

Our proposed improvements incorporate the stepwise threshold clustering algorithm to group together similar reads[3]. These reads will then be aligned to both a reference (wild-type) genome and a collection of known alleles (alleles are variations from the wild-type reference). After reviewing the regions these reads potentially represent, we will then incorporate a novel mapping algorithm that considers subtle differences in variation between homologous regions. This approach maps reads with less resulting ambiguity than alignment to the reference alone could have accomplished.

FORWARD THINKING / INNOVATION

The project's algorithm is a part of an emerging class of bioinformatics tools to incorporate data for known variations in the reference version of the genome[4,5]. As genome scientists expand their knowledge of human genetic variation, these tools will become more sensitive to data that challenge today's analyses. This project has come about from the collaboration between Marquette University, the Blood Center of Wisconsin, and the Medical College of Wisconsin. We hope that this project will allow laboratories at the Blood Center of Wisconsin, the Medical College of Wisconsin, and elsewhere to provide more accurate and sensitive genetic testing services.

STUDENT INVOLVEMENT

This work represents the work of David McKean's master's thesis under Dr. Bozdag's supervision. David will work on the computational experiments in this project.

REFERENCES

1. Anderson, M. W. & Schrijver, I. Next Generation DNA Sequencing and the Future of Genomic Medicine. *Genes* **1,** 38–69 (2010).
2. Brandt, D. Y. C. et al. Mapping Bias Overestimates Reference Allele Frequencies at the HLA Genes in the 1000 Genomes Project Phase I Data. *G3: Genes | Genomes | Genetics* **5**, 931–941 (2015).
3. Stutz, W. E. & Bolnick, D. I. Stepwise Threshold Clustering: A New Method for Genotyping MHC Loci Using Next-Generation Sequencing Technology. *PLoS ONE* **9**, e100587–20 (2014).
4. Sirén, J., Välimäki, N. & Mäkinen, V. Indexing Graphs for Path Queries with Applications in Genome Research. *IEEE/ACM Trans Comput Biol Bioinform* **11**, 375–388 (2014).
5. Huang, L., Popic, V. & Batzoglou, S. Short read alignment with populations of genomes. *Bioinformatics* **29**, i361–70 (2013).

PROJECT TITLE: Disaggregation problem: How much is a daily gas flow of a monthly gas bill?

FACULTY NAMES: Ronald. H. Brown, and George Corliss

STUDENT NAME: Maral Fakoor

INTRODUCTION

Natural gas Local Distribution Companies (LDCs) usually want to purchase the amount of natural gas that their customers will need every day. If an LDC is going to provide services to new geographic zones defined as operating areas, or if a national gas demand model (for example consumption models for some states in the US) is to be built, available data may be only the monthly and billing cycle natural gas consumption.

SIGNIFICANCE

In natural gas LDCs too little or too much purchased risks either trading gas on the spot market at a premium price, or paying penalties to pipeline companies. Especially, when there is an unusual condition like unexpected weather. Hence, there is a need to have an accurate daily forecast to reduce the operational cost of LDCs and subsequently to reduce the price for the natural gas customers. Daily natural gas flow forecasting uses mathematical models based on domain knowledge.

FORWARD THINKING

In our model daily gas flow data are what we really need to build accurate gas forecasting models. If the interval data are the only data available for training, this can cause large errors when trying to forecast daily flow. So we need to disaggregate monthly and billing cycle data to daily data. In this project we want to build forecast model by minimizing the gas flow forecasting errors for a target area.

STUDENT INVOLVEMENT

For disaggregating monthly and billing cycle data there are some models which are used for other projects. But we need to implement a method which is more dependent on our constraints such as weather condition like temperature and wind.

REFERENCES

- Moauro, F. and Savio, G. (2005) Temporal disaggregation using multivariate structural time series models. Econ-metr. J., 8, 214–234.
- Christoph Sax and Peter Steiner, “Temporal Disaggregation of Time Series,” MPRA Paper No. 53389, posted 6. March 2014.
- Boot, J.C.G., Feibes, W. and Lisman, J.H.C. (1967)"Further methods of derivation of quarterly figures from annual data", Applied Statistics, vol. 16, n. 1, p. 65-75.
- Rossi, N. (1982)"A note on the estimation of disaggregate time series when the aggregate is known", Review of Economics and Statistics, vol. 64, n. 4, p. 695-696.
- Di Fonzo, T.(1990)"The estimation of M disaggregate time series when contemporaneous and temporal aggregates are known", Review of Economics and Statistics, vol. 72, n. 1, p. 178-182.
- S. R. Vitullo, “Disaggregating time series data for energy consumption by aggregate and individual customers,” Doctoral thesis, 2011.

PROJECT TITLE:

IMPACT OF PRIOR DAY WEATHER CONDITION ON DAILY GAS DEMAND

FACULTY:

Dr. Ronald Brown, Dr. George Corliss

STUDENTS:

Babatunde Ishola, Jarrett Smalley

INTRODUCTION:

Residential and commercial natural gas demand is driven mainly by daily temperature as most natural gas is used for space heating. In addition to daily temperature, prior day temperature is known to be a significant in determining daily gas demand. To build an efficient regression model to forecast gas demand, it is necessary to understand the relationship the dependent variable (gas demand) and independent variables (such as daily temperature, and prior day temperature). While the relationship between gas demand and current day temperature is known to be linear, the impact of prior day temperature is not. This is due to thermodynamics and human behavioural factors. The objective of this work is to investigate the effect of prior day temperature as well as other prior weather condition on daily gas demand.

SIGNIFICANCE

Prior Day Weather Sensitivity (PDWS) is a quantitative metric that describes by how much today's gas demand is impacted by yesterday's weather factor(s). PDWS is also important as it needed in calculating the prior day temperature for an hypothetical design day. A design day being an event with the maximum probable gas demand for which the gas distribution system is designed to handle. PDWS was previously determined to be a constant value for a given operation area[1]. Understanding the possible relationship between PDWS and temperature will help to improve the current GasDay regression model. PDWS was evaluated for different temperature ranges, with results indicating that PDWS varies nonlinearly with temperature. Accounting for this nonlinearity in the base model is significant as it resulted in a significant increase in forecast accuracy, which in turn will assist natural gas providers to save money and keep their systems in good condition.

FORWARD THINKING/INNOVATION

There is a great amount of potential for innovation in this area of research. Multiple other variables, besides temperature as investigated here, may have an impact on Prior Day Weather Sensitivity. As shown in this research so far, finding a variable that affects PDWS can ultimately lead to making the GasDay model more accurate.

STUDENT INVOLVEMENT

This work represents a portion of Babtunde Ishola's Master's Thesis with assistance from Jarrett Smalley. Drs. Ronald Brown and George Corliss will act as advisors to Babatunde Ishola and Jarrett Smalley's work.

REFERENCES

[1] Kaefer, Paul E. "Transforming Analogous Time Series Data to Improve Natural Gas Demand Forecast Accuracy." (2015).

PROJECT TITLE

Evaluating the Cybersecurity of the GasDay Project

FACULTY NAMES

Dr. Ronald H. Brown, Dr. George Corliss

STUDENT NAME

Andrew Kirkham

INTRODUCTION

Networked systems offer a wide variety of potential security weaknesses, including misconfigured systems, unintentionally public information, or out of date systems. We want to find such vulnerabilities before an attacker does. We present penetration testing as a method to identifying vulnerabilities and minimizing future security incidents. Penetration testing is the process of attempting to gain access to resources of an organization without knowledge of any valid credentials [2].

SIGNIFICANCE

As more applications move to be connected to the internet or abstracted into the cloud, cybersecurity increasingly becomes a concern. The idea of security through isolation or security through obscurity no longer holds when applications are moved into an abstract environment like the cloud or when previously disconnected devices become connected to the internet. The energy industry is attacked by hackers many times a year [1]. A single successful attack could result in millions of stolen identities. Penetration testing allows an organization to simulate an attacker in order to evaluate the security of their systems.

INNOVATION

Several large technology companies publish the results of penetration tests [3, 4], but this practice does not often extend to the energy industry. As natural gas and electric companies begin to use smart-meters, protecting the confidentiality and integrity of this data will be paramount. We present GasDay as a case study both as a member of the natural gas industry and as a research lab at Marquette University. We will use state-of-the-art tools in attempt to penetrate through the network and discover vulnerabilities that threaten the security of data. We aim to improve the security of natural gas companies, GasDay, and Marquette as a result of this research.

STUDENT INVOLVEMENT

The research being done will be the target of the student's Master's thesis. The student will perform the necessary research and experimental work under the supervision of faculty advisors. The student will also submit the results of the work to research conferences in related fields.

REFERENCES

[1] C. Wueest, "Targeted attacks against the energy sector," *Symantec Security Response, Mountain View, CA*, 2014.
[2] Penetration Test Guidance Special Interest Group and PCI Security Standards Council, "Penetration Testing Guidance," Mar. 2015.
[3] "Google Security Whitepaper," *Google Developers*. [Online]. Available: https://cloud.google.com/security/whitepaper.
[4] Amazon, "Amazon Web Services: Overview of Security Processes," Amazon Web Services, Jun. 2014.

PROJECT TITLE

Expanding High School CS Education: A New Installment of MUzECS

FACULTY NAME

Dr. Dennis Brylow

STUDENT NAMES

Omokolade Hunpatin, Luke Mivshek, Casey O'Hare

INTRODUCTION

Exploring Computer Science ("ECS") is an introductory high school curriculum aimed increasing the accessibility of Computer Science education to all students, but particularly women and underrepresented minorities. The Exploring Computer Science curriculum has proven effective in its goal in high schools around the country, and Marquette leads a National Science Foundation-funded effort to launch ECS in districts across Wisconsin.

SIGNIFICANCE

The field of computer science is growing rapidly, with unfilled jobs in the tech industry outstripping degree production by a large factor every year. Two important factors prevent us from addressing this shortfall effectively: too few high schools (around 8% in Wisconsin) offer any Computer Science coursework, and even at schools that have CS courses, the students who succeed in them remain overwhelmingly white and male, or Asian and male. Solution strategies must help to attract and retain students from the other 70% of the U.S. population, and spread to the more than 90% of high schools that currently have no such opportunities.

FORWARD THINKING/INNOVATION

The ECS curriculum has proven to be successful in diversifying the CS student population in other states, and more than 20 school disctricts in Wisconsin are now piloting versions of this courses. Our team has successfully created a cheaper platform for ECS's expensive final robotics module. At one tenth the cost of the LEGO Mindstorms, our new solution utilizes Arduino Leonardo and a custom circuit board "shield", on which peripherals are mounted. The next steps entail adding more peripherals to our shield in order to increase the range of projects students can produce with our system. Accelerometers, thermometers, pressure sensors, and LCD screens are among the many possibilities. During the rollout of our "MUzECS" module in 2015, students used our custom variant of Ardublock, an open source block-based programming language, which controls the hardware platform. However, the growing prevalence of low-cost Chromebooks in area schools presents a technical challenge for installing specialized software. Our proposed solution is to complete a browser-based alternative to Ardublock, which streamlines installation problems and supports Chomebook-only school districts. A large pilot of this is planned for spring term of 2016, and we are producing additional hardware and the new web-based software now.

STUDENT INVOLVEMENT

This project is entirely driven by student researchers developing the hardware, software and curriculum. The initial team began in the summer 2014 Research Experience for Undergraduates program in the MSCS Department, and continued through a AY 2014-15 senior design capstone project. The current team continued through the 2015 summer REU.

REFERENCES

[1] "Ardublock." Ardublock. N.p., n.d. Web. 1 Nov. 2015.
[2] "Exploring Computer Science." Exploring Computer Science. N.p., 2015. Web. 1 Nov. 2015.
[3] "LEGO®." LEGO.com Mindstorms. N.p., n.d. Web. 1 Nov. 2015.

Title:

Weather Normalized Use

Faculty Name:

Dr. George Corliss

Student Name:

Maria Dela Sancha

Introduction:

There are a couple techniques in use that attempt to calculate the weather normalized natural gas demand. This interprets as, what the demand would have been had the weather been normal. While these techniques are similar, they do not give the same results given the same data. Local Distribution Companies claim that some of these techniques do not work well when the weather is seasonally far from normal. Currently, the ambiguities of what defines normal have prevented gas practitioners and analysts to come up with a base case that can be used to compare the accuracy of individual techniques.

Significance:

In the past years the weather normalized used has been used for many things. One of those things is forecasting and rate calculations. This is essential to local distribution companies and for the common people. These methods help calculate and explain the change of prices, profit, or loss for both parties. In gas demand forecasts, underestimates means local distribution companies have to pay more for transportation and higher prices for gas. Overestimates also costs companies money, they are fined and have to additionally pay for extra storage.

Forward Thinking/Innovation:

While the true results of 100% accurate data of normalized demand might exist, we will never know the exact calculation because of the ambiguity of what defines normal. How do we determine better? Research in the behavior of demand and factors needed to normalize it can help us determine which method to use. We must also understand the cause of using these techniques and what gas practitioners and any other analyst using these methods need from them. In the case of rate involvement, we need to have data with less variability that provides smoother graphs. How do we test for this? Similar problems in other fields like economics have use linear regression and many other statistical methods.

Student Involvement

Provide graphs and analyze data from a chosen LDC. Study the behavior using statistical methods like regression analysis, variance tests, and confidence intervals. Use these results to compare techniques. Come up with a couple test cases for these techniques.

References

[1] Heating and Cooling Degree Days Long Term Averages. Melbourne: Bureau of Meteorology, Meteorological Information Services, 1983. Heating and Cooling Degree Days. EPA, May 2014. Web. July 2015.

[2] Ronald H. Brown, Steven R. Vitullo, George F. Corliss, Monica Adya, Richard J. Povinelli. (2015) "Detrending Daily Natural Gas Consumption Series to Improve Short-Term Forecasts," IEEE Power and Energy Society General Meeting (PESGM), Denver, Colorado.

[3] (2010, May 1). American Gas Association (AGA), [Online].

PROJECT TITLE

Partial Least Squares Regression on Hourly Weather Inputs

FACULTY NAME

George Corliss, Senior Research Scientist/Professor Emeritus, Electrical and Computer Engineering
Ronald Brown, Associate Professor, Electrical and Computer Engineering

STUDENT NAME

Andrew Tran

INTRODUCTION

Partial least squares (PLS) regression is an iterative algorithm that performs simultaneous decomposition of independent and dependent variables to explain as much as possible the covariance between both variables [1]. PLS is popular for computational chemistry and biology because PLS is able to handle large amounts of independent variables relative to the amount of dependent variables. Developed by Herman Wold, PLS is an algorithm based off principle component analysis with the caveat that both the independent and dependent variables be relevant to each other [2]. The relevance is important in that the model looks to optimize the error based on the relationship between the independent and the dependent variables. The algorithm can be used in other regression or forecasting models that have large amounts of independent variables.

SIGNIFICANCE

Natural gas forecasting use regression models to make predictions on gas demand. Many variables can be used to determine how much natural gas will be needed; however, using too many inputs will not be computationally efficient. PLS regression can be the solution for optimizing the set of inputs used in natural gas forecasting.

FORWARD THINKING/INNOVATION

Currently, GasDay chooses between 20-30 inputs from 1000 different inputs for their hourly gas demand forecasts, which are used in a linear regression model. Current practice chooses the best performing 20-30 inputs from a genetic algorithm [3]. This practice possibly eliminates significant inputs to the model which limits the inputs being used in the model. I propose using partial least squares (PLS) regression instead of the genetic algorithm. PLS estimates values based on explaining the most covariance between all the input and all the output variables. PLS should perform better than our genetic algorithm, because PLS uses all the variables, which will then be optimized for the best performance.

STUDENT INVOLVEMENT

The research is being done by the student with advisement from the faculty named above. The data analysis and method process is being done by the student as well.

REFERENCES

[1] Abdi, Hervé. "Partial Least Square Regression (PLS Regression)." Print.

[2] Wold, Herman. "Estimation of principal components and related models by iterative least squares." *Multivariate analysis* 1 (1966): 391-420.

[3] Lim, H. L., and Ronald H. Brown. "Hourly Gas Load Forecasting Model Input Factor Identification using a Genetic Algorithm". *Proceedings: 44th IEEE Midwest Symposium on Circuits and Systems (Dayton, OH).* August, Dayton, OH. IEEE , 2001. 670-673. Print.

Which evaluation metric is the best for evaluating probabilistic forecast?

Mohammad Saber, George F. Corliss, and Richard J. Povinelli

GasDay Laboratory, EECE dept.

Forecasting is useful to make decision and planning in meteorology, energy industry, stock market, economics, sports, politics and lots of other areas. Lots of research has been done to guess the exact event of the future which is called point forecast. Forecasting is nothing but pattern searching from historical evidences to guess the future. If human behavior and weather factors are involve in the forecasting process, then it's become very difficult to predict due to the nature of data. The point forecast is always wrong considering the unavoidable uncertainties of such kind of historical data. The uncertainties of the forecast can be captured using a technique called probabilistic forecast.

Probabilistic forecast represents forecast in the form of interval associated with a probability distribution. Currently there is no well stablished evaluation metric to measure the effectiveness of a probabilistic forecast which is considered one of the reasons for less published work in this area. The literature of probabilistic forecast uses Pinball loss function, Winkler score, Brier score, and some other scoring methods. Which method is more useful to identify the best probabilistic forecast? If there is no absolute best then which method works better under a specific situation and vice-versa? What does each of the evaluation metric actually mean to us? Do they capture everything what we actually need? If not, how can we improve those existing evaluation metrics to meet our requirements?

Keywords: Load forecasting; Probabilistic forecast; Evaluation metrics; Score; Pinball loss function; Winkler score; Brier score.

PROJECT TITLE

Autonomic Synchronicity, Group Dynamics, and Performance

FACULTY

Stephen J. Guastello, Ph.D., Psychology Department

STUDENTS

David Marra, Julian Castro, Maribeth Gomez, Kati Bishop, Michael Equi, Liana Hariri, Michael Esson, and Nicholas Callard Psychology Department

INTRODUCTION

Synchronization of physiological behaviors (EEG, GSR, body movements) between people are observed in work team performance and dyadic interactions. This project investigates the impact of synchronization of autonomic arousal (GSR) impacts on team performance and a team's experience of cognitive workload and fatigue (CWLF). At present there is no consensus regarding how the individual experiences of workload compile into a group workload (Funke et al., 2012). The trend in thinking, however, is that group workload is a function of individual workload, and group processes such as mutual monitoring, coordination demand, psychological synchronization, communication styles, adaptability, and leadership (Salas et al., 2015). Group-level fatigue has not been addressed at all.

SIGNIFICANCE

We take the perspective that group-level events emerge from the individual experiences and group interactions to form patterns that continue to exert a downward influence on the group's behaviors. Underneath these dynamics lies a common denominator: physiological synchronization in autonomic arousal among co-workers. Here individuals assume roles of drivers, who have the greatest impact on the team members' physiological responses, and empaths, who are most receptive to the other members' arousal trends. Several strains of extant research involving nonlinear dynamical processes for cognitive workload and fatigue (Guastello, 2014), group coordination, and leadership emergence (Guastello, 2009) are combined and integrated in this project.

FORWARD THINKING INNOVATION

The project involves an extensive integrated experiment in which Emergency Response Teams consisting of 4 or 8 members work against 1 or 2 adversaries in the context of a board game (The Creature That Ate Sheboygan). Participants wear GSR sensors, which collect data on autonomic arousal. Performance and game participation behavior are also monitored on a turn-by-turn basis in a 6-game tournament. Researchers are investigating how the levels of synchronization in team members' GSR data affect group performance, group coordination, and the emergence of leadership, and the combined relationships among these variables to individual and team-level workload.

STUDENT INVOLVEMENT

Students in the CWLF lab have been involved in theoretical development and the design of experiments, collecting data, assisting with the data analysis, interpreting results, and defining future directions for the project.

REFERENCES

Funke, G. J., Knott, B. A., Salas, E., Pavlas, D., & Strang, A. J. (2012). Conceptualization and measurement of team workload: A critical need. *Human Factors, 54*, 36-51.

Guastello, S. J. (2009). Group dynamics: Adaptability, coordination, and leadership emergence. In Guastello, S. J., Koopmans, M., & Pincus, D. (Eds.), *Chaos and complexity in psychology: Theory of nonlinear dynamical systems* (pp. 402-433). New York: Cambridge University Press.

Guastello, S. J. (2015). Catastrophe models for cognitive workload and fatigue: Memory functions, multitasking, vigilance, financial decisions and risk. *Proceedings of the Human Factors and Ergonomics Society, 58*, 908-912.

Salas, E., Stevens, R., Gorman, J., Cooke, N. J., Guastello, S. J., & von Davier, A. (2015). What will quantitative measure of team work look like in 10 years? *Proceedings of the Human Factors and Ergonomics Society, 59*, 235-239.

PROJECT TITLE

Implementation of a Treadmill Mounted on a 6 Degree of Freedom Motion Simulator Platform for Measuring Dynamic Gait in Individuals with Multiple Sclerosis

FACULTY MENTORS

Dr. Allison Hyngstrom PT, PhD and Dr. Brian Schmit PhD

STUDENTS

Mr. Timothy Boerger MS ATC, PhD student, CTRH, College of Health Sciences

INTRODUCTION

Falls are a major cause of injury in patients with neurological injury, including multiply sclerosis (Frankel and Schneider 2014). Current methods to assess risk of falls and rehabilitation programs to prevent falls are currently deficient because they typically examine balance responses during static conditions or simplistic walking environments. These methods are primarily limited by current mainstream technology. In order to examine gait on uneven terrain in a laboratory or clinical environment, members of our laboratory have produced a state of the art system with a treadmill mounted onto a motion simulator platform. To date, much of the research on this technology has focused on assessing whole body measures of posture such as step length, velocity, and center of mass displacement (Collins et al., 2015; van der Meer, 2014). Our novel treadmill system will allow us to go beyond these conventional measures and obtain critical knowledge regarding balance responses during walking in people with multiple sclerosis. To our knowledge, no research has been presented exploring three dimensional, joint-specific measures of humans walking, such as assessing variations in ankle, knee, and hip joint angles, velocities, and accelerations.

SIGNIFICANCE

Overground walking during everyday life frequently involves traversing uneven surfaces due to cracks in pavement, rocks, sticks, and, in certain populations, occupational factors such as the deck of a ship at sea. Moreover, many times over ground walking involve multiple degrees of unevenness simultaneously such as walking up and down hills, over uneven pavement or rocks, and having to turn either direction. These complex motions can present major challenges and limitations to patients with neurological diseases such as multiple sclerosis, stroke, or traumatic brain injuries The National Multiple Sclerosis Society, for example, has highlighted uneven terrain as a potential risk of fall for those with MS (Frankel & Schneider, 2014). Data from these studies will be used to create novel balance training paradigms for people with Multiple Sclerosis.

FORWARD THINKING/INNOVATION

The proposed study is highly innovative for several reasons. First, in the present study, we seek to utilize a custom designed treadmill mounted motion simulator system in the study of walking in persons with multiple sclerosis and healthy adults. Second, we propose a novel measurement of walking. We will be performing 3 dimensional motion analysis in order to assess joint-specific motion as a response to changes in platform pitch, roll, and combined pitch, roll, and yaw. Third, we are innovative because we will also seek to compare these previously described outcome measures to conventional clinical measures such as the dynamic gait index. These oscillations in pitch, roll, and yaw allow us to simulate some of the uneven surfaces which are encountered in everyday life. We anticipate that individuals who are less able to effectively utilize both their hips and ankles to control posture will have greater overall postural disturbances compared to healthy individuals. By exploring how healthy adults efficiently respond to these oscillating platform motions compared to those who have difficulty with uneven surfaces, we may be better able to design rehabilitation programs for individuals with multiple sclerosis.

STUDENT INVOLVEMENT

The student has been and will be involved in all aspects of the research process including conceptual design, writing of this abstract, data collection, data analysis, and dissemination of results.

REFERENCES

Collins, J.-D., Markham, A., Service, K., Reini, S., Wolf, E., & Sessoms, P. (2015). A systematic literature review of the use and effectiveness of the Computer Assisted Rehabilitation Environment for research and rehabilitation as it relates to the wounded warrior. *Work*, *50*(1), 121–129.

Frankel, D., & Schneider, D. (2014). Minimizing Your Risk of Falls [PDF]. Retrieved October 8, 2015, from http://www.nationalmssociety.org/NationalMSSociety/media/MSNationalFiles/Brochures/Brochure-Minimizing-Your-Risk-of-Falls.pdf

van der Meer, R. (2014). Recent developments in computer assisted rehabilitation environments. *Military Medical Research*, *1*(22), 1–7.

PROJECT TITLE: Deep Neural Networks in Kaldi

FACULTY NAME: Professor Michael T.Johnson

STUDENT NAME: Narjes Bozorg

INTRODUCTION:

Over the past few years, the state-of-the-art in speech recognition systems has changed from Hidden Markov Model (HMM) based statistical models to HMMs driven by Deep Neural Networks (DNNs). The Marquette Speech and Signal Processing laboratory has been working with standard research tools such as the HTK HMM toolkit, but this system is no longer state-of-the-art and needs to be updated. Newer tools have been developed for the research community, including specifically the KALDI open-source speech recognition system [1,2]. The goal of this project is to develop a new speech recognition platform for research in speech recognition systems at Marquette, based on the KALDI framework.

SIGNIFICANCE:

The significance of this work is to improve the overall baseline recognition accuracy of the Marquette Speech and Signal Processing Laboratory's speech recognition platform, which will enable continued research in this area. Several of the labs research tools, including our speaker independent acoustic-to-articulator inversion system, will benefit from this improved platform.

FORWARD THINKING:

Deep Neural Networks (DNN) have been proposed as powerful method for speech recognition, and are now used bymany well-known companies, such as Google,for speech processing and recognition. This project will enable Marquette to maintain pace with developments in this important field.

REFERENCES:

[1] Y. Miao, "Kaldi+ PDNN: building DNN-based ASR systems with Kaldi and PDNN," *arXiv preprint arXiv:1401.6984*, 2014.

[2] D. Povey, A. Ghoshal, G. Boulianne, L. Burget, O. Glembek, N. Goel, M. Hannemann, P. Motlíček, Y. Qian, P. Schwarz, and others, "The Kaldi speech recognition toolkit," 2011.

COMPARING PERFORMANCE OF ACOUSTIC-TO-ARTICULATORY INVERSION BETWEEN NATIVE AND NON-NATIVE SPEAKERS

Dr. MICHAEL JOHNSON, Dr. JEFFREY BERRY

SEYEDRAMIN ALIKIAAMIRI

INTRODUCTION

Acoustic to articulatory inversion is an approach that estimates articulatory measures of the vocal tract shape and characteristics from a speech signal. This process is important in various applications that can make use of precise articulatory information, such as computer aided pronunciation training (CAPT). The articulatory parameters for this system have been trained using data from Marquette's Electro Magnetic Articulograpy corpus of Mandarin-Accented English (EMA-MAE). Prior collaborative work in the Speech and Signal Processing Laboratory has successfully implemented and tested acoustic-to-articulatory inversion for native speakers of English. We propose to study the accuracy of this approach on non-native English speakers, specifically native Mandarin speakers who are second-language English learners. By comparing the accuracy of the system for native and non-native speakers, we will be able to evaluate the expected effectiveness of the system for CAPT applications

SIGNIFICANCE

The significance of this project is its application to Computer Aided Language Learning (CALL) and specifically to CAPT.The underlying goal of this work is to provide highly accurate pronunciation feedback to language learners that will enable them to improve their pronunciation.

STUDENT INVOLVEMENT

Students in the Speech and Signal Processing laboratory will be involved in the process of implementing the inversion and comparing the accuracy of the approach for non-native English speakers in contrast to native speakers.

REFERENCES

[1] A. ji, Speaker independent acoustic to articulatory inversion, Phd Dissertation, Marquette University, Milwaukee, 2009.

PROJECT TITLE

Kinematic Templates for Automatic Pronunciation Assessment

FACULTY NAMES

Dr. Michael Johnson, Dr. Jeffrey Berry

STUDENT NAME

Deriq Jones

INTRODUCTION

As part of the NSF-funded study "RI: Small: Speaker Independent Acoustic-Articulator Inversion for Pronunciation Assessment", the Marquette Speech and Swallowing Lab and Marquette Speech and Signal Processing Lab are preparing to conduct a pilot study on the use of acoustic-to-articulatory inversion for Computer Aided Pronunciation Training (CAPT). The Acoustic-to-Articulator inversion system developed through this project analyzes English speech and predicts the motion of the articulators, including the jaw, lower lip, upper lip, and tongue, required to produce the corresponding sounds. In order to give the system a frame of reference for pronunciation assessment, kinematic templates are needed for the system. The current project focuses on development of such kinematic templates, based on both acoustic and articulatory data from native-English speakers. These templates will be used in the planned pilot study in order to determine if the system provides a feasible method of performing pronunciation assessment on Mandarin-Accented English speakers.

SIGNIFICANCE

The significance of this work is its application to the field of Computer Aided Language Learning (CALL), most notably CAPT. The underlying goal of this work is to provide high-quality pronunciation feedback to language learners in order to enable them to more quickly and accurately improve their pronunciation patterns.

STUDENT INVOLVEMENT

Graduate students in the Marquette Speech and Signal Processing lab will work together with graduate and undergraduate students in the Marquette Speech and Swallowing lab to implement this project.

REFERENCES

[1] J. Berry, A. Ji and M. Johnson, EMA-MAE Corpus User's Handbook, 2014.

[2] A. Ji, Speaker Independent Acoustic-To-Articulatory Inversion, Marquette University, 2014.

PROJECT TITLE: Effects of mechanical vibration on the biological behaviors of osteoblasts cultured on dental implant material surface
FACULTY NAME: Dawei Liu, DDS MS PhD, Associate Professor, Dentistry
STUDENT NAME: Alex Schwab DDS, Jason Meinhardt DDS (1st year orthodontic residents)

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

SIGNIFICANCE
Without knowing whether mechanical vibration promotes proliferation and differentiation of osteoblasts cultured on dental material surface, it is impossible to provide scientific evidence based on which mechanical vibration can potentially be applied to promote the success and longevity of dental implants. In this study, MC3T3-E1 pre-osteoblasts will be seeded at a density of $4x10^5$/well on the discs of dental implant material (to be provided by Straumann Inc.) in 12-well cell culture dishes. The cells will be subjected to mechanical vibration (0.3g, at 0, 30, 60 and 90 Hz respectively) or kept under static culture condition without vibration as control. The cells will be vibrated 1 hour a day for consecutive 14 days. Cell proliferation will be assessed on day 0, 3, 5, 7, 14 by using MTT method. While differentiation will be examined by day 14 using van Kossa staining. One-way ANOVA will be used to compare the differences of each parameter between the vibrated and the non-vibrated groups, with Tukey comparison to be used to find out the difference between various frequencies. P value less than 0.05 is considered statistically significant.

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

STUDENT INVOLVEMENT Alex Schwab DDS, Janson Meinhardt DDS (1st orthodontic residents) will participate in this project. They will be involved in designing and implementing experiments, analyzing data and writing research paper.

REFERENCES
1. Li X et al. Biomaterials. 2015; 36:44-54.
2. Zhao L et al. Med Hypotheses. 2009; 72(4):451-2.

PROJECT TITLE: The effects of mechanical vibration on human chondrocytes under loading in vitro

FACULTY NAME: Dawei Liu, DDS MS PhD, Associate Professor, Dentistry
STUDENT NAME: Brian Michel DDS, Louis Wenger DDS, Bradley Wurm DDS

INTRODUCTION

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

SIGNIFICANCE

The effects of mechanical vibration (<1g and <100Hz) on the biological responses of chondrocytes to mechanical loading is unknown. Clearly, lack of this knowledge will prevent us from recognizing the potential damage dental vibration can do to the TMJ and finding a way to prevent it. Therefore, the effects of vibration on chondrocytes under mechanical loading will be studied as follows. Human chondrocytes (a gift from Dr. Mary Goldring) will be seeded at a density of $4x10^5$/well in 6-well plates. From day 1, the cells will be subjected to a static mechanical loading (a stretching of 10% cell surface area), with or without mechanical vibration (0.3g, with 0, 30, 60 and 90 Hz respectively) 1 hour/day for 14 consecutive days, with the cells only under static load as control. Proliferation of the chondrocytes will be examined on day 0, 3, 5, 7 and 14 by using MTT method. While the differentiation of the chondrocytes will be assessed on day 14 by staining alcian blue, alkaline phosphatase and collagen II – all three markers for chondrocyte differentiation. To study the signaling pathways involved, the chondrocytes under loading will be subjected to mechanical vibration for only 1 hour. Gene expressions of SOX9, Wnt5a and Runx2 will be examined by real-time PCR while their protein productions evaluated by Western Blot. One-way ANOVA will be used to test the difference of each parameter between vibrated and non-vibrated groups, with Tukey comparison to be used to find the difference between various frequencies ($P<0.05$ is considered statistically significant).

FORWARD THINKING/INNOVATION

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

STUDENT INVOLVEMENT Brian Michel DDS, Louis Wenger DDS, Bradley Wurm DDS (1st year orthodontic residents) will participate in designing and implementing experiments, analyzing data and writing research papers.

REFERENCES

1. Fricton J et al. J Orofac Pain. 2010; 24: 237-54. Review.
2. Liu J et al. Mod Rheumatol. 2001; 11(1):40-6.
3. Liu D. Journal of Dental Research. 92 (Spec Iss A): Abstr. No. 1773, 2013

PROJECT TITLE: "Improving services to the Hispanic community through technology-enhanced pronunciation training of L2 Spanish-speaking SLPs"

FACULTY NAMES: Steven H. Long, Ph.D., CCC-SLP, Associate Professor, Speech Pathology & Audiology; Sonia Barnes, Ph.D., Assistant Professor, Foreign Languages & Literature; Jeffrey J. Berry, Ph.D., CCC-SLP, Associate Professor, Speech Pathology & Audiology.
STUDENT NAMES: Julissa G. Bello-Almazan, B.S.E. in Communication Disorders, Graduate, Speech Pathology & Audiology; Mahala E. Berry, Undergraduate, Speech Pathology & Audiology

INTRODUCTION

The objectives of the project are to complete a two-part research study pertaining to accented speech in second language learners of Spanish. First, we will conduct an acoustic study of the differences between speech sound productions in native Spanish speakers compared to second language learners of Spanish. This data will expand current knowledge about the acoustic characteristics of speech sounds in Spanish and of characteristics of English-accented Spanish. These analyses will support the second phase of our research, using auditory feedback-driven adaptive learning to elicit more native-like pronunciation from native English speakers of Spanish. Recent research in the Marquette Speech & Swallowing Lab has demonstrated that auditory feedback manipulations can be used to elicit subtle changes in tongue, lip, and jaw movements during speech that affects pronunciation. Simply put, a speaker is instructed to produce a target speech sound while hearing himself through headphones. What the speaker hears—the feedback—is then digitally manipulated to elicit a more native-like pronunciation. The change in pronunciation results from adaptive learning, since the speaker involuntarily compensates for the subtle feedback manipulations to learn the new pattern of articulation. This method improves the learner's auditory discrimination and articulation abilities, bolstering self-monitoring skills.

SIGNIFICANCE

According to the U.S. Census Bureau, at least 37.5 million Americans speak Spanish at home [1]. Spanish-speaking Americans account for 62% of the total U.S. population of individuals who speak a language other than English. Nearly half of Spanish-speaking Americans identify themselves as speaking English "less than very well." Consequently, the current job market seeks to employ proficient bilingual Spanish-English speakers who are able to communicate in both languages at a professional level. Research has shown that increases in perceived accents negatively impact judgments of employability, likely due to the social connotation that accented speech suggests limited cultural sensitivity [2]. Our auditory feedback approach to accent reduction will likely increase the clarity of Spanish in non-native bilingual speakers, modifying their productions to be more native-like and thus increasing perception of membership in the native-speaking community. We believe that our advanced approach to pronunciation improvement holds great promise for reducing the amount of accent evidenced in a second language. It is an innovative application of technology in an area of foreign language instruction where experts agree that traditional methods have very limited effectiveness.

FORWARD THINKING/INNOVATION

While current treatment approaches to accent modification exist, these revolve around techniques that describe non-accented elements. Our proposed study would help to provide concrete information about the acoustic differences between two language groups: native Spanish speakers and native English speakers of Spanish. The data obtained will be used in the development of an efficacious therapy technique with a firm scientific basis that embraces advances in speech learning technology.

STUDENT INVOLVEMENT

Julissa Bello-Almazan and Mahala Berry will recruit and screen participants, run experiments, analyze data, and help develop manuscripts characterizing the results of the acoustical study and the secondary pronunciation learning research. With the support of Dr. Long, Dr. Barnes, and Dr. Berry acoustical data will be obtained through audio recordings of native and non-native Spanish speakers. Ms. Bello-Almazan and Ms. Berry will complete data analyses of the obtained recordings and consult current research to accurately define the dominant acoustic and articulatory features of English-accented Spanish. The research will then be used to develop an auditory feedback manipulation study that will elicit native productions of Spanish speech sounds with technology that is already developed and utilized in Dr. Berry's lab.

REFERENCES

[1] Ryan, C. (2013). Language use in the United States: 2011. Washington, DC: US Census Bureau.
[2] Carlson, H. K., & McHenry, M. A. (2006). Effect of accent and dialect on employability. *Journal of Employment Counseling, 43*(2), 70-83.

PROJECT TITLE:

Investigating the Relationship Between Actin and Amyloid Formation

FACULTY NAME:

Anita L. Manogaran

STUDENT NAME:

Douglas Lyke

INTRODUCTION AND SIGNIFICANCE:

Protein misfolding is associated with many neurodegenerative diseases, such as Alzheimer's, Parkinson's, Huntington's, and Prion disease. Together, these brain disorders affect millions of Americans each year, leading to health care costs in the billions of dollars. Furthermore, it has been projected that one in four Americans will be diagnosed with a neurodegenerative disorder[1], leading to mounting concerns about how to manage and treat the increasing number of patients. Given its public health importance, there is an *urgent need* to understand how these diseases develop in order to prevent their occurrence. In each of these diseases, a specific protein misfolds and converts other normally folded versions of itself to the misfolded form, which is called amyloid. While the nature of amyloid formation suggests shared pathways among these diseases, it is unclear what cellular mechanisms underlie this commonality. Our lab is interested in the cellular mechanisms underlying the early steps of amyloid formation associated with these diseases.

Studying amyloid formation in humans or mammals is extremely challenging due to the immense complexity of these systems. Therefore, our lab turns to the much simpler, yet highly conserved, cellular system of Baker's yeast in order to understand amyloid formation. A single region where misfolded proteins collect in the cell, called the insoluble protein deposit (IPOD), has been proposed to be the site of amyloid formation[2]. Our recent work shows that loss of an important actin associated protein, Sac6p, leads to multiple IPOD and a decrease in amyloid formation[3,4]. Therefore, our data suggests that amyloid formation is likely linked to both actin networks and IPOD.

FORWARD THINKING/INNOVATION:

The work proposed here will focus upon the *relationship between actin networks, IPOD, and amyloid formation*. Using a combination of both biochemical techniques and 3D fluorescent live cell imaging, we will characterize the interactions between actin networks and IPOD and determine how these two cellular processes impact amyloid formation.

STUDENT INVOLVEMENT

The graduate student associated with this project, Doug Lyke, has generated the preliminary IPOD data for this proposal. All strain construction, 3D fluorescent live cell imaging, and data collection will be performed by Doug Lyke. Data analysis and interpretation will be performed in collaboration with the PI.

REFERENCES:

1. Labhasetwar, V. (2011). Neurodegenerative diseases: challenges. *Drug Deliv and Transl Res*. **1**, 349-350.
2. Tyedmers, J., Treusch, S., Dong, J., McCaffery, JM., Bevis, B., Lindquist, S. (2010). Prion induction involves an ancient system for the sequestration of aggregated proteins and heritable changes in prion fragmentation. *Proc. Natl. Acad. Sci. USA*. **107**, 8633-8638.
3. Manogaran, AL., Hong, JY., Hufana, J., Tyedmers, J., Lindquist, S., Liebman, SW. (2011). Prion formation and polyglutamine aggregation are controlled by two classes of genes. *PLoS Genet*. **7**, e1001386.
4. Lyke, D., and Manogaran, AL (unpublished)

PROJECT TITLE

Investigating the impact of thermal stress on *de novo* [*PSI*$^+$] formation.

FACULTY NAME

Anita L. Manogaran

STUDENT NAME

Derek Yeh

INTRODUCTION AND SIGNIFICANCE

Alzheimer's, Huntington's, Parkinson's and Prion disease are fatal neurodegenerative disorders that share similar underlying mechanisms: protein misfolding and amyloid formation. In neurodegenerative disorders, proteins undergo an alternative, yet stable, misfolded conformation that recruits other native proteins to misfolded form called amyloid. Specifically in Prion disease, the prion amyloid formed is unique because it is infectious. Under normal conditions, misfolded proteins are refolded or directed to degradation by protein quality control (PQC) mechanisms. It appears that PQC may act on misfolded amyloid in a different manner, yet these mechanisms are not well understood. To better understand the mechanisms in amyloid formation and PQC, our lab studies prion formation in baker's yeast, or *Saccharomyces cerevisiae*.

The yeast model system provides a simple means to study amyloid formation *in vivo*. In addition to the short generation time and easy genetic manipulation, yeast have endogenous prions that behave similar to mammalian prions. The yeast prion [*PSI*$^+$] is the misfolded amyloid conformation of the protein, Sup35p. Previous work has shown that elevated levels of the PQC chaperone protein, Hsp104, can the cure the cell of a pre-existing [*PSI*$^+$] prion[1,2] . Yet, it is unclear whether Hsp104 plays a role in the process of forming a prion.

We have recently have shown that upon transient heat stress, the formation of [*PSI*$^+$] is reduced compared to cells that have not been treated with heat[3]. The transient heat stress is correlated with elevated levels of Hsp104, suggesting that Hsp104 may play an important role in *de novo* [*PSI*$^+$] formation[4].

FORWARD THINKING/INNOVATION

Our work will better understand the role of Hsp104 along with other PQC proteins, in [*PSI*$^+$] formation. This understanding will support future research using molecular chaperones for targeted therapeutics in amyloid diseases.

STUDENT INVOLVEMENT

Derek Yeh, a second year graduate student in the Manogaran lab, has performed the preliminary work in the proposal. Derek will perform future experiments and collect data for this project. Data analysis and interpretation will be conducted by both Derek and the PI.

REFERENCES

1. Chernoff, YO., Lindquist, SL., Ono, B., Inge-Vechtomov, SG., Liebman, SW. (1995). Role of the chaperone protein hsp104 in propagation of the yeast prion-like factor [*PSI*$^+$]. *Science* **268**, 880-884.
2. Shorter, J., Lindquist, SL. (2004). Hsp104 catalyzes formation and elimination of self-replicating Sup35 prion conformers. *Science* **304**, 1793-1797.
3. Yeh, D. and Manogaran, AL (unpublished)
4. Morimoto RI. (2011). The heat shock response: systems biology of proteotoxic stress in aging and disease. *Cold Spring Harbor Symposia on Quantitative Biology*. **76,** 91-99.

PROJECT TITLE: An interactive likelihood for the multi-Bernoulli filter
FACULTY NAME(S): Dr. Henry Medeiros
STUDENT NAME(S): Anthony Hoak, Juan E. Tapiero Bernal

INTRODUCTION

Recently, there has been much research in the use of random finite sets within a Bayesian framework for multi-target tracking [1][2]. For example in [3], a Bayesian multi-target multi-Bernoulli filter is presented that uses images directly for sensor measurements. A fundamental requirement of the multi-Bernoulli filter is for targets to remain separated within the image [1][3]. However, it is often the case that a relatively large number of targets are in very close proximity or even possibly occlude one another, for example in sport player tracking. This type of situation can lead to numerous, ambiguous measurements (referred to as clutter). It one of the major challenges of multi-target tracking to appropriately associate these ambiguous measurements with targets [4]. This process of associating measurements and targets is called data association. If data association is not handled adequately, there can be a loss of target tracks (tracks can be thought of as the evolution of the target's state through time), target tracks/labels may be switched, leading to overall tracking accuracy. Particle filter implementations are especially sensitive to data association as particles are not inherently associated with a specific target. Therefore, when multiple targets are in close proximity, the particles of one target are influenced by the particles of other existing targets. One way to reduce this effect is to make the particle weights inversely proportional to its distance to other particles for all other existing targets and incorporate this interactive weighting function into the likelihood calculation of the multi-Bernoulli filter.

SIGNIFICANCE

Multi-target tracking applications are varied and numerous. Multi-object systems are used in automatic video surveillance, robotics [3], sonar systems, guidance and navigation, and air traffic control [1]. Additionally, many intercontinental ballistic missile defense radar systems use multi-target tracking algorithms such as the joint probabilistic data association filter and the multiple hypothesis tracker [5]. However, most of the algorithms in use today make assumptions about target motion, system and measurement noise, and are therefore not optimal. The particle filter implementation of the multi-Bernoulli filter does not require these assumptions and is therefore theoretically a more powerful tool. But it does suffer from the problem described above in the Introduction. The interactive likelihood is a theoretically sound method for eliminating the need for external data association mechanisms, which is entirely based in the Bayesian random finite sets framework.

FORWARD THINKING/INNOVATION

The proposed interactive likelihood scheme is a novel method for addressing a fundamental issue in the field of multi-target tracking.

STUDENT INVOLVEMENT

Dr. Henry Medeiros is directing the research project. Anthony Hoak is responsible for the implementation and evaluation of the interactive likelihood for the multi-Bernoulli filter. Juan E. Tapiero Bernal is assisting in the performance evaluation of the interactive likelihood.

REFERENCES

[1] Ba-Ngu Vo, Ba-Tuong Vo, Nam-Trung Pham and D. Suter, "Joint Detection and Estimation of Multiple Objects From Image Observations," *Signal Processing, IEEE Transactions on,* vol. 58, pp. 5129-5141, 2010.

[2] Ba-Ngu Vo, Ba-Tuong Vo, N. T. Pham and D. Suter, "Bayesian multi-object estimation from image observations," in *Information Fusion, 2009. FUSION '09. 12th International Conference on,* 2009, pp. 890-898.

[3] R. Hoseinnezhad, B. Vo, B. Vo and D. Suter, "Visual tracking of numerous targets via multi-Bernoulli filtering of image data," *Pattern Recognit,* vol. 45, pp. 3625-3635, 10, 2012.

[4] D. B. Reid, "An algorithm for tracking multiple targets," *Automatic Control, IEEE Transactions on,* vol. 24, pp. 843-854, 1979.

[5] Y. Bar-Shalom, F. Daum and J. Huang, "The probabilistic data association filter," *Control Systems, IEEE,* vol. 29, pp. 82-100, 2009.

PROJECT TITLE
MULTI-TARGET TRACKING USING MULTI-BERNOULLI FILTERING AND DEEP CONVOLUTIONAL NEURAL NETWORKS

FACULTY NAME
DR. HENRY MEDEIROS

STUDENT NAME
REZA JALIL MOZHDEHI

INTRODUCTION
Multi-target tracking consists of estimating the number of targets and their states [1]. Optical flow is one of the most widely used methods for video-based object tracking. It is popular due to its efficiency and the ability to estimate flows for sparse feature points [2]. In fact, the optical flow recognizes moving objects while estimating their velocities. Although optical flow is fast, it is not very robust. It cannot resolve problems such as occlusions and gradual changes in target appearance [3]. To improve the performance of the optical flow, we propose to use deep neural networks to learn the dynamic model of our specific object as well as to automatically learn how to segment it from the background [4].

SIGNIFICANCE
Multi-target tracking has many applications in diverse disciplines including, biomedical, air traffic control, intelligence, surveillance, space applications, oceanography, autonomous vehicles and robotics, and remote sensing [1]. Also, segmentation is a pivotal element in image analysis and is hence a critical element in a robust visual tracking system [4].

FORWARD THINKING / INNOVATION
We propose a complete and accurate algorithm for tracking a specific target in the presence of clutter. There are four main steps to the development of our proposed method. In the first step, we will recognize moving objects via optical flow. We will then apply a filter in order to reduce the amount of noise. The third step employs a multi-Bernoulli filter in order to track a specific target among various other moving objects. Preliminary results indicate that the proposed algorithm can effectively track a specific moving target. We will extend this tracker by developing a novel deep neural network to learn target motion models and appearance directly from the image data.

STUDENT INVOLVEMENT
Mr. Reza Jalil Mozhdehi, a PhD student in the EECE department, will design and evaluate the proposed algorithms.

REFERENCES

[1] Mahendra Mallick and et al, “Introduction to the Issue on Multitarget Tracking”, IEEE Journal of Selected Topics in Signal Processing, Vol. 7, No. 3 (2013)

[2] Erkang Chen and et al, “Quaternion based optical flow estimation for robust object tracking”, Journal of Digital Signal Processing, Vol. 23, pp. 118-125 (2013)

[3] In Hwan Choi and et al, “Arbitration algorithm of FIR filter and optical flow based on ANFIS for visual object tracking”, Journal of Measurement, Vol. 75, pp. 338-353 (2015)

[4] Erkang Chen and et al, “Modified Self Organizing Feature Map Neural Network (MSOFM NN) Based Gray Image Segmentation”, Journal of Procedia Computer Science, Vol. 54, pp. 671-675 (2015)

Project Title: A Fast GPU-Based Approach to Branchless Distance-Driven Projection and Back-Projection in Cone Beam CT

Faculty Name: Dr. Henry Medeiros

Student Name: Daniel Schlifske

Introduction

Modern CT image reconstruction algorithms rely on projection and back-projection operations to refine an image estimate in iterative image reconstruction. A widely-used state-of-the-art technique is distance-driven projection and back-projection [1][2]. This method has been used in many effective image reconstruction algorithms. For example, the high-quality Ordered Subset Expectation Maximization (OSEM) algorithm [3] for PET image reconstruction is based on distance-driven projection and back-projection [4]. Additionally, the distance-driven method has been used in a 3D regularized iterative reconstruction algorithm for Helical CT called MAP-ICD [5].

Significance

While the distance-driven technique yields superior image quality in iterative algorithms, it is a computationally demanding process. It is not unheard of for certain regularized image reconstruction algorithms to take longer than ten minutes. This has a detrimental effect on the relevance of the algorithms in clinical settings. Indeed, lower quality image reconstruction algorithms are frequently used in hospitals in order to maximize the number of patients that can be scanned per day. In some cases, low quality algorithms could lead to misdiagnosis.

Forward Thinking/Innovation

This study explores a solution to significantly speed up distance-driven projection and back-projection without compromising image quality. The technique is named “pre-projection integration” because it achieves a performance boost by integrating the data before the projection and back-projection operations. It was written with Nvidia’s CUDA framework and carefully designed for massively parallel graphics processing units (GPUs). Both projection and back-projection are significantly faster with pre-projection integration. The image quality was analyzed using cone beam CT image reconstruction algorithms within Jeffrey Fessler’s Image Reconstruction Toolbox. Images produced from regularized, iterative image reconstruction algorithms using the pre-projection integration method show no significant artifacts.

Student Involvement

Dr. Henry Medeiros is directing the research project. Daniel Schlifske is working on the implementation of the method, optimization for performance, and evaluation of the results.

References

[1] De Man, Bruno, and S. Basu. "Distance-driven projection and backprojection." Nuclear Science Symposium Conference Record, 2002 IEEE. Vol. 3. IEEE, 2002.

[2] De Man, Bruno, and Samit Basu. "Distance-driven projection and backprojection in three dimensions." Physics in medicine and biology 49.11 (2004): 2463.

[3] Hudson, H. Malcolm, and Richard S. Larkin. "Accelerated image reconstruction using ordered subsets of projection data." *Medical Imaging, IEEE Transactions on* 13.4 (1994): 601-609.

[4] Manjeshwar, Ravindra M., et al. "Fully 3D PET iterative reconstruction using distance-driven projectors and native scanner geometry." *Nuclear Science Symposium Conference Record, 2006. IEEE*. Vol. 5. IEEE, 2006.

[5] Thibault, Jean-Baptiste, et al. "A three-dimensional statistical approach to improved image quality for multislice helical CT." *Medical physics* 34.11 (2007): 4526-4544.

MULTIPLE-CAMERA MULTIPLE-TARGET TRACKING WITH LABELED MULTI-BERNOULLI FILTER

Faculty: Henry Medeiros **Student:** Juan Esteban Tapiero Bernal, Anthony Hoak

Introduction

The increasingly widespread availability of camera networks monitoring public areas in major cities around the world opens up the possibility of the creation of novel collaborative algorithms that rely on the information provided by multiple cameras to keep track of multiple targets as they travel along the common field of view of the network. However, to date there has been very few works that attempt to explore this availability of redundant data within a cohesive multi-target state estimation framework. The few works that do account for the decentralized nature of the multi-camera target tracking problem have very limited scope. They either focus exclusively on the spatio-temporal tracking aspects of the problem, completely disregarding the visual information provided by multiple cameras or employ separate trackers for each target instead of a global multi-target tracker, hence underutilizing the information provided by the spatio-temporal constraints [3]. In this project, we propose a multi-camera recursive estimation algorithm based on random finite sets, which are a class of recursive Bayesian estimation methods that allow for a variable number of targets to be tracked [1]. More specifically, our tracker will be based on the labeled Multi-Bernoulli filter, which is known to be amenable to distributed implementations [4]. We will use the concept of track-before-detect in order to integrate the visual target likelihood into the recursive filter. In track-before-detect approaches, instead of applying a detection mechanism that computes the target state based on the current image and then provides this information to an estimation mechanism that attempts to compute the optimal trajectory of the target, the visual information is fed directly into the estimator so that it can account for the likelihood that the observation actually corresponds to the target [2]. In our proposed approach, cameras that have partially overlapping fields of view will be allowed to collaborate and exchange information about the likelihood of the targets and hence make more accurate predictions about the global state of the target.

Significance

This project aims to improve the performance of multi-target tracking algorithms using information collected by multiple cameras, which is important, for example, for surveillance and robotic applications.

Forward Thinking/Innovation

The novelty of this project is the use of the relationship between cameras to improve the measurements models which are fundamental for the proper operation of random finite set filters.

Student Involvement

The Student Juan E. Tapiero will develop the multi-camera tracking algorithms and will implement and test a system to evaluate it.

References

[1] Ronald PS Mahler, *Statistical multisource-multitarget information fusion*, Artech House, Inc., 2007.
[2] Maggio, Emilio, and Andrea Cavallaro. *Video tracking: theory and practice*. John Wiley & Sons, 2011.
[3] Aghajan, Hamid, and Andrea Cavallaro, eds. *Multi-camera networks: principles and applications*. Academic press, 2009.
[4] Reuter, S., Vo, B. T., Vo, B. N., & Dietmayer, K. "The labeled multi-Bernoulli filter." *Signal Processing, IEEE Transactions on* 62.12 (2014): 3246-3260.

MULTIPLE PEDESTRIAN TRACKING WITH HUMAN MOTION MODELS FROM CROWD MODELING

Faculty: Henry Medeiros, Robert H. Bishop **Student:** Juan Esteban Tapiero Bernal

Introduction

In the literature related with tracking of humans and a wide variety of objects, there are usually a set of simple motion models that are mixed or used individually to model the different possible maneuvers [6]. The most widely used motion models are the constant velocity or linear motion model and the constant acceleration model, but for maneuvering targets there are models like the coordinated turn and models with higher orders of dynamic description that model the forces acting on the objects to obtain a more detailed representation of the expected motion. We want to use a model with a more realistic description that takes in account the forces acting on the targets since it would allow us to model different maneuvers and do other analysis given the states estimates obtained. Human motion in crowds and in the presence of other individuals has been previously studied [1] [2] mostly based on the seminal paper on social forces [3]. This usually has been done thinking about building design and evacuation processes. More recently, in the case of multiple-target tracking the concept of interaction and social forces has also found some applications, good examples are [4] [5] where basically different approaches for the parametrization of the forces are taken. We aim to introduce a general body diagram formulation of the forces model and model parametrization for general multiple target tracking applications where the state space is only dependent on the state of one particular target at the time and the number of pedestrians detected in the scene.

Significance

This project is done with the aim of improving the accuracy of autonomous surveillance systems and introducing more detailed motion descriptions for pedestrian tracking.

Forward Thinking/Innovation

The main innovation is the development of a model than can be used in general multiple-target tracking techniques without making interaction (inter-state dependencies) assumptions that violate the probabilistic assumption that are heart of the tracking techniques.

Student Involvement

The Student Juan E. Tapiero will develop the parametrization and formulation of the model and will incorporated it in different tracking techniques.

References

[1] M. Moussaid, D. Helbing, S. Garnier, A. Johansson, M. Combe, and G. Theraulaz, “Experimental study of the behavioural mechanisms underlying self-organization in human crowds”, Proceedings.Biological sciences The Royal Society, vol. 276, no. 1668, pp. 2755-2762, Aug 7 2009.
[2] Mehdi Moussad, Niriaska Perozo, Simon Garnier, Dirk Helbing, and Guy Theraulaz,“The walking behaviour of pedestrian social groups and its impact on crowd dynamics”, 2010.
[3] Dirk Helbing and Peter Molnar, “Social force model for pedestrian dynamics”, Physical review E, vol. 51, no. 5, pp. 4282, 1995.
[4] Matthias Luber, Johannes Stork, Gian Diego Tipaldi, and Kai O. Arras, “People tracking with human motion predictions from social forces”, in IEEE International Conference on Robotics and Automation (ICRA). 2010, pp. 464-469, IEEE.
[5] Stefano Pellegrini, “Modeling and tracking social walkers”, 2012.
[6] Maggio, Emilio, and Andrea Cavallaro. *Video tracking: theory and practice*. John Wiley & Sons, 2011.

Characterization of calcium dependent potassium currents in the neonatal rat hippocampus

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Calcium influx through voltage dependent L-type calcium channels is highly regulated, particularly in the early neonatal period. Changes in calcium influx can affect a variety of neuronal responses including gene expression and excitability. The close proximity of L-type calcium channels to calcium dependent potassium (K^+) channels suggest that regulation of the L-type channels may lead to changes in excitability. Repolarization and afterhyperpolarization of neuronal membranes following an action potential is due to influx of K^+ through a variety of different K^+ channels including calcium dependent channels. Calcium activated K^+ channels can be divided into large conductance (BK), small conductance (SK) and KCNQ channels. Enhancing calcium influx could lead to greater or less excitability depending on whether the effects of calcium are greater on the action potential repolarization or afterhyperpolarization. In the present study we investigated the effects of calcium influx through L-type channels on K^+ currents and described the properties of these currents in neonatal rat hippocampal neurons. The goal is to have a better understanding of how these calcium dependent K^+ channels affect action potential duration and the afterhyperpolarization specifically in neonatal neurons thereby altering excitability of the cell. K^+ currents were measured with the whole cell patch clamp technique in voltage clamp mode using cultured neurons obtained from 2-10 day old rat pups and maintained in culture for 16-40 hours. Neonatal hippocampal neurons exhibited both a transient current, I_A, and a sustained current, I_K. Currents were measured by depolarizing the cell from -50 mV to +50 mV in 10 mV increments. Currents elicited from a holding potential of -90 mV displayed both I_A and I_K. When cells were held at -50 mV, the transient I_A was largely inactivated, leaving primarily I_K. The current-voltage relationship of K^+ currents demonstrated rectification of the transient current. In larger neurons (>13 pF, N=9) treatment with the L-type calcium channel antagonist nimodipine (40 μM), decreased sustained K^+ current by an average of 64.7±6.9% while only decreasing the transient current by an average of 30.7±5.5%. Smaller neurons (<9 pF, N=2) lacked the transient component and exhibited had a 35% average inhibition of the sustained component. These data suggest that calcium activated K^+ channels are primarily involved in I_K. Future experiments will look at how blocking different calcium activated K^+ channels affects the I_K and I_A current types, action potential repolarization, and afterhyperpolarization.

PROJECT TITLE

"Strategic Planning as Organizational Ritual"

FACULTY NAME

John Pauly, professor and chair, Journalism and Media Studies, Gretchen and Cyril Colnik Chair in Communication

STUDENT NAME

Stephanie Melendrez, master's student in communication

INTRODUCTION

Organizations of all sorts regularly engage in strategic planning. When explaining the purposes of such planning, they typically speak of the need to allocate their resources rationally and effectively, and to respond to opportunities or threats in the environment. Strategic planning thus declares a moment at which organizations consciously attempt to reinvent themselves by choosing to invest their time, people, money, and reputation in some activities rather than others.

From a communication perspective, however, moments of strategic planning are also deeply rhetorical. They enact a ritual in which organizations symbolically declare their deepest purposes and commitments to a variety of audiences, including employees, shareholders, customers, journalists, and the public.

SIGNIFICANCE

This project analyzes the practice of strategic planning in order to assert a general theoretical claim: that our interpretations of organizational behavior tend to overstate the presumed rationality of organizational goals, processes, and leadership, and understate the importance of symbols, drama, and rituals. The project's more specific and ultimate goal is to apply this mode of ritual analysis to the history of strategic planning in the American university. How and why have universities adopted the rhetoric and rituals of strategic planning? What are the cultural implications of treating universities as market actors whose purposes and modes of work can be reinvented by each new cohort of leaders?

FORWARD THINKING/INNOVATION

The goal is for Pauly and Melendrez to co-author a convention paper or journal article by the end of the spring 2016 semester. This project extends a line of research by Sarah Feldner, Kati Berg, and Pauly, on organizational mission statements as public performances of corporate identity.

STUDENT INVOLVEMENT

Stephanie Melendrez is working as a research assistant on this project, doing bibliographic research on strategic planning and on dramaturgical approaches to communication analysis.

REFERENCES

Lee E. Bolman and Terrance Deal, *Reframing Organizations: Artistry, Choice and Leadership,* 4th ed. (Wiley, 2008).

Hugh Dalziel Duncan, *Communication and Social Order* (Bedminster Press, 1962).

Dennis A. Goia and Kumar Chittipeddi, "Sensemaking and Sensegiving in Strategic Change Initiation," *Strategic Management Journal,* 12 (1991): 433-48.

Dennis A. Gioia, Majken Schultz, and Kevin G. Corley, "Organizational Identity, Image, and Adaptive Instability," *Academy of Management Review,* 25 (2000): 63-81.

Henry Mintzberg, *The Rise and Fall of Strategic Planning* (Free Press, 1994).

PROJECT TITLE

Using Deep Neural Networks to Forecast Energy Demand

FACULTY NAME(S)

Richard Povinelli

STUDENT NAME(S)

Greg Merkel

INTRODUCTION

Marquette University's GasDay Project specializes in daily natural gas forecasting and uses artificial neural networks and linear regression to model gas demand. Recently, data scientists and machine learning experts have started using deep neural networks to replace backpropagation neural networks in solving their problems and have, in general, found better solutions. The purpose of this project is to use deep neural networks to forecast natural gas and electricity demand and compare their performance to existing methods.

SIGNIFICANCE

The GasDay Project actively works with about 30 natural gas utilities which account for approximately 18-20% of the United States natural gas consumption. A small improvement to GasDay's forecasting methods can have huge impact, saving the utilities and their customers millions of dollars annually. If deep neural networks prove to be as effective in energy forecasting as they have been in solving other machine learning problems, it will have a large impact on the energy industry.

FORWARD THINKING/INNOVATION

Deep learning technologies have been applied to a variety of high dimensional and non-linear machine learning problems such as stock prediction, speech recognition, motion capture, to video processing. Some researchers have tried to apply these technologies to the energy industry but with limited success, in large part due to lack of data and domain knowledge. The GasDay Project has access to almost one million data points and over 20 years of domain knowledge, which make it well placed to be the first to effectively apply deep neural networks to energy forecasting.

STUDENT INVOLVEMENT

The majority of the work on this project will be done by the student, Greg Merkel. Dr. Richard Povinelli, along with Dr. Ronald Brown and Dr. George Corliss, will advise him and help determine the direction of the project, but nearly all research and implementation will be done by the student.

REFERENCES

- http://www.gasday.com
- M. Längkvist, L. Karlsson, A. Loutfi, "A review of unsupervised feature learning and deep learning for time series modeling", Pattern Recogn. Lett., 42 (2014), pp. 11–240
- Kuremoto, Takashi, et al. "Time series forecasting using a deep belief network with restricted Boltzmann machines." *Neurocomputing* 137 (2014): 47-56.
- Boulanger-Lewandowski, Nicolas. "Modeling High-Dimensional Audio Sequences with Recurrent Neural Networks." (2014).
- Qiu, Xueheng, et al. "Ensemble deep learning for regression and time series forecasting." *IEEE SSCI 2014-2014 IEEE Symposium Series on Computational Intelligence-CIEL 2014: 2014 IEEE Symposium on Computational Intelligence in Ensemble Learning, Proceedings*. Institute of Electrical and Electronics Engineers Inc., 2015.
- Busseti, Enzo, Ian Osband, and Scott Wong. *Deep learning for time series modeling*. Technical report, Stanford University, 2012.
- Dalto, Mladen. "Deep neural networks for time series prediction with applications in ultra-short-term wind forecasting." *Rn (Θ1)* 1: 2.

Project Title

Evaluating the Impact of Supplemented Medical-Surgical Simulation Learning Experiences on Clinical Decision Making and Clinical Competence

Faculty and Student Names

Aimee Woda PhD, RN BC Faculty, Jamie Hansen MSN, RN CNE Doctoral Student, and Penny Alt-Gehrman MSN Doctoral Student.

Introduction

An emerging nursing education trend is to supplement hospital learning experiences (HLE) with simulation learning experiences (SLE) as a means to optimize student clinical competency and clinical decision making (CDM) skills. However, there is insufficient research to guide faculty in determining the ideal amount of SLE in relationship to HLE in order to achieve the most favorable student learning outcomes. A better understanding of evidence-based practices to integrate SLE into nursing curricula may lead to better use of resources.

Significance

The addition of SLE using high fidelity simulations (HFS) within nursing curricula may be one teaching strategy to improve CDM and clinical competence among nursing students. The National Council of State Boards of Nursing identified that 50% of traditional hospital learning experiences (HLE) can be substituted with SLE rendering no statistically significant difference in clinical competency (Hayden et al., 2014). However, it is unknown whether the use of HFS practicums to supplement HLE produces additional effects on clinical competency and perceived CDM. The optimal amount of HFS needed in coordination with HLE experiences has yet to be determined. The purpose of this study is to determine if supplementing HLE with SLE, vs substituting HLE with SLE has an impact on nursing students' clinical competence and their perception of CDM. A quasi-experimental design will be utilized to compare two groups of graduating nursing students. In Group 1, SLE were substituted for HLE; in Group 2, SLE were used to supplement HLE.

Forward Thinking/Innovation

Preliminary findings will identify if supplementing verses substituting SLE impacts graduating nursing students' clinical competence and their perceived CDM. This study will provide beginning evidence to guide schools of nursing in curriculum development that may allow flexibility in providing high-fidelity simulated learning in relationship to hospital-based clinical practicums based on student needs and available resources.

Student Involvement

Data from group 1 (35 May 2015 graduates) has been collected and data from group 2 will be collected during May of 2016 (approximately 50). The two doctoral students will assist in data collection from group 2 during May of 2016. The two doctoral students will enter and analyze data from both group 1 and 2 that includes The Clinical Decision Making in Nursing Scale a 40-item self-report instrument measuring categories of CDM and The Nurse Anxiety and Self-Confidence with Clinical Decision Making a 27-item self-report instrument that measures the participants' perceptions of their level self-confidence and anxiety with CDM. The graduate students will also evaluate the students' clinical competence during a HFS using The Creighton Competency Evaluation Instrument (CCEI).

References

Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries. (2014). The NCSBN national simulation study: A longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. *Journal of Nursing Regulation, 5*(2).

Project Title

The Impact of High Fidelity Human Simulation on Newly Licensed Registered Nurses Perception of Competency, Work Stress, and Job Satisfaction

Faculty and Student Names

Aimee Woda PhD, RN BC Faculty, Jamie Hansen MSN, RN CNE Doctoral Student, and Penny Alt-Gehrman MSN Doctoral Student.

Introduction

Challenges exist for nursing students as they transition into their role as a newly licensed registered nurses (NLRN) due to a mismatch between their perceived readiness and role competency, and the demands of the practice environment. The addition of simulation learning experiences (SLE) using high fidelity simulations (HFS) within nursing curricula may be one teaching strategy to better prepare students for the transition to the role of a practicing nurse.

Significance

There is a need to determine how to best integrate SLE with traditional hospital-based learning experiences (HLE) in nursing curricula. The National Council of State Boards of Nursing identified that 50% of traditional HLE can be substituted with SLE rendering no statistically significant difference in clinical competency and readiness for practice (Hayden et al., 2014). However, it is unknown whether the use of HFS practicums to supplement HLE produces additional effects on clinical competency, which may decrease work stress, and increase job satisfaction among the NLRN in the workplace. The optimal amount of HFS needed in coordination with HLE experiences has yet to be determined.

The purpose of this study is to determine if supplementing HLE with SLE, vs substituting HLE with SLE has an impact on NLRN perception of competence, work stress, and job satisfaction. A quasi-experimental design will be utilized to compare two groups of NLRN at six months of practice; In Group 1, SLE were substituted for HLE; in Group 2, SLE were used to supplement HLE.

Forward Thinking/Innovation

This pilot work is important because the findings will set the foundation for larger multi-site studies to establish best practices for the use of HFS across nursing curricula and evaluate the long-term effects of this new pedagogy on NLRNs' perception of competence, work stress, and job satisfaction.

Student Involvement

The doctoral students will assist with the distribution, data entry, and data analysis of the instruments used in this study. The Work Stress survey is a four question 4-point Likert-type scale questionnaire ($\alpha = 0.78$) used to determine participant's perceptions of work stress. Job satisfaction will be assessed with the Brayfield & Rothe Index of Job Satisfaction (Brayfield & Rothe, 1951) ($\alpha = 0.88$) that contains six questions on a 5-point Likert-type scale (disagree-agree). To determine NLRNs' self-perception of competency the Overall Competency and the Specific Competency tools will be utilized. The NLRN will rate themselves on six items from disagree to agree using the Overall Competency Tool ($\alpha = 0.88$) (Spector, et al., 2015). The Specific Competency Tool has 34 items (disagree-agree) that identifies the NLRN perception of teamwork, communication, patient-centered care, evidence based practice/quality improvement, and use of technology ($\alpha = 0.89$-0.93). The doctoral students will also assist in literature searches, manuscript preparation, and dissemination of results.

References

Brayfield, A., & Rothe, H. (1951). An index of job satisfaction. *Journal of Applied Psychology, 35*(5), 307-311.

Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries. (2014). The NCSBN national simulation study: A longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. *Journal of Nursing Regulation, 5*(2).

Spector, N., Blegen, M.A., Silvestre, J., Barnsteiner, J., Lynn, M.R., Ulrich, B., Fogg, L., & Alexander, M. (2015). Transition to practice study in hospital settings. *Journal of Nursing Regulation, 5*(4), 24-38.

PROJECT TITLE

H_∞-Property of the Discrete-Time Extended Kalman Filter for Systems with Uncertain Measurements

FACULTY NAMES

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

STUDENT NAME

Jennifer L. Bonniwell, PhD Student, EECE Department

INTRODUCTION

The Kalman filter [1] is the minimum variance state and parameter estimator for linear systems. The design of the Kalman filter has been extended to be a locally optimal minimum variance estimator for nonlinear systems through linearization about the current estimate as presented in [2] and [3], among others; this design is well known as the extended Kalman filter (EKF). The EKF is used in thousands of applications, e.g. in estimation of vehicle velocities in [4] and for system identification in [5]. In addition to applications of the EKF, various performance properties of the EKF have been analyzed in previous works. Convergence studies have been performed to show under what conditions the discrete-time EKF will work [6]-[10].

Modified EKFs have also been developed for different system and measurement models over the years; the model considered in this work is the uncertain measurement model. Much work has been completed for Kalman filtering of a similar model, the intermittent measurement (packet-loss) model, but there is a void when considering uncertain measurements. Wang and Yaz derived an extended Kalman filter for the uncertain measurement model in [11].

SIGNIFICANCE

Through Lyapunov analysis, this work will show that the EKF for the uncertain measurement model inherently has the finite-time H_∞-property in addition to being a locally optimal minimum variance state estimator for nonlinear systems in the presence of finite-energy noise. This property implies that the EKF can also function as a local nonlinear observer with a disturbance attenuation property for systems with finite-energy disturbances.

FORWARD THINKING/INNOVATION

In the proposed work, Lyapunov analysis will be performed to obtain a bound on the finite-time H_∞-gain for the discrete-time EKF for systems with uncertain measurements. Simulations will be provided to compare the theoretical bound to the actual H_∞-gain.

STUDENT INVOLVEMENT

The student will use Lyapunov analysis to obtain bounds on the H_∞-gain for the discrete-time EKFs for systems with uncertain measurements. She will also perform simulations to verify the result.

REFERENCES

[1] R. Kalman, “A New Approach to Linear Filtering and Prediction Problems,” Journal of Basic Engineering, vol. 82, no. 1, pp. 35- 45,1960.

[2] F. L. Lewis, Optimal Estimation, New York: Wiley, 1986.

[3] D. Simon, Optimal State Estimation, New Jersey: Wiley, 2006.

[4] H. Guo, H. Chen, F. Xu, F. Wang, G. Lu, “Implementation of EKF for Vehicle Velocities Estimation on FPGA,” IEEE Transactions on Automatic Control, vol. 60, no. 9, pp. 3823-3835, 2013.

[5] J. K. Rice, and M. Verhaegen, “Efficient System Identification of Heterogeneous Distributed Systems Via a Structure Exploiting Extended Kalman Filter,” IEEE Transactions on Automatic Control, vol. 56, no. 7, pp. 1713-1718, 2011.

[6] K. Reif, E. Yaz, and R. Unbehauen, "Stochastic Stability of the Discrete-Time Extended Kalman Filter," IEEE Transactions on Automatic Control, vol. 44, no. 4, pp. 714-28,1999.

[7] S. Bonnabel and J. Slotine, “A Contraction Theory Based Analysis of the Stability of the Deterministic Extended Kalman Filter,” IEEE Transactions on Automatic Control, vol. 60, no. 2, pp. 565-569, 2015.

[8] M. Boutayeb, H. Rafaralahy, M. Darouach, “Convergence Analysis of the Extended Kalman Filter Used as an Observer for Nonlinear Deterministic Discrete-Time Systems,” IEEE Transactions on Automatic Control, vol. 42, no. 4, pp. 581-586, 1997.

[9] K. Reif, R. Unbehauen, “The Extended Kalman Filter as an Exponential Observer for Nonlinear Systems,” IEEE Transactions on Signal Processing, vol.47, no. 8 pp. 2324-2328, 1999.

[10] Y. Song and J. W. Grizzle, “The Extended Kalman Filter as a Local Asymptotic Observer for Discrete-Time Nonlinear Systems,” Journal of Mathematics and System Estimation and Control, vol. 5, no. 1, pp. 59-78, 1995.

[11] X. Wang and E. E. Yaz, “Stochastically Resilient Extended Kalman Filtering for Discrete-Time Nonlinear Systems with Sensor Failures,” International Journal of Systems Science, vol. 45, no. 7, pp. 1393- 1401, 2014.

PROJECT TITLE: "Performance Analysis of Resilient Controllers for Continuous-time Systems with both Multiplicative and Additive Gain Perturbations"

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, an analysis procedure is presented to evaluate the resilience property of a state feedback controller for continuous-time systems. After designing the controller using eigenvalue placement techniques, the designers will be able to determine upper bounds on the allowable deviations from nominal that the controller gains can have while still maintaining the performance specifications required by the designer, specified by eigenvalue locations. These bounds are determined using linear matrix inequality (LMI) techniques [1].

SIGNIFICANCE

A controller for which significant performance deterioration occurs due to a small perturbation in the controller or observer gains is referred to as a "fragile" or "non-resilient" controller [2]. In practice, since more and more implementations of controllers and observers are done digitally by microprocessors, resulting numerical round-off errors in computation are sources of these perturbations. Also, some implementations need manual tuning of the gains to obtain the best performance of the controller. For these reasons, it is desired to design a resilient controller that will be capable of tolerating changes, readjustments and errors of the control gains.

FORWARD THINKING / INNOVATION

This work assumes both multiplicative and additive perturbations in controller gains, which allows a higher degree of uncertainty or errors in the modeling. Based on the choices for the eigenvalue locations for the closed loop system, a performance analysis will be presented to determine the resilience bound for the controlled system.

STUDENT INVOLVEMENT

In previous research on 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. Feng will investigate the effect of the perturbations for controller gain and the maximum bounds of the perturbations. A variety of desired eigenvalue region specifications will also be investigated to satisfy different performance criteria, such as settling time, percent overshoot, etc. [3].

REFERENCE

[1] S. Boyd, L. ElGhaoui, E. Feron, and V. Balakrishnan, Linear Matrix Inequalities In System and Control Theory, SIAM Studies in Applied Mathematics, SIAM, Philadelphia, 1994.
[2] L. H. Keel and S. P. Bhattacharyya, Robust, fragile, or optimal? IEEE Trans. on Automat. Control, vol. 42, 1997, 1098 – 1105.
[3] Graham C. Goodwin and Kwai Sang Sin, Adaptive Filtering Prediction and Control, Prentice-Hall, Englewood cliffs, NJ, 1984.

PROJECT TITLE

Convergence Properties of a Linear Minimum Variance Unbiased Estimator

FACULTY NAMES

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

STUDENT NAME

Alia R. Strandt, Ph.D. Candidate, EECE Department

INTRODUCTION

Networked systems are becoming increasingly common as more devices are interconnected, and within these systems, managing communication between devices becomes more challenging as the number of devices increases. One possible problem associated with these systems is random data packet loss or sensor failure. In many cases the probability of data loss is unknown, which can have significant effects on the operation of the overall system as well as individual devices within that system. To address this issue, estimation techniques have been developed that can estimate the value of the system states as well as the mean of the probability of data loss.

SIGNIFICANCE

Controls designers have many different options when selecting estimators for various systems, including networked systems. It is the responsibility of the designer to select the estimator best suited for the particular application under consideration. Several different aspects of the estimators must be considered, among them how quickly the estimator converges to the correct value. However, for some estimation techniques, convergence time is not well-researched. By investigating the mean convergence time of estimation techniques, designers are more able to accurately assess these techniques for their particular applications.

FORWARD THINKING/INNOVATION

In the proposed work, the convergence properties of a bank of linear minimum variance unbiased estimators as found in [1] and [2] will be analyzed. The various dependencies of convergence time for this estimation method will be identified, and if possible, a representation of mean convergence time from these dependencies will be developed.

STUDENT INVOLVEMENT

The student will study the linear minimum variance unbiased estimator bank proposed in [1] and [2]. Initially, the simulation results found in [1] for a representative first order system are reproduced. The signal to noise ratio (SNR) of the system, which is dependent on the system covariance, the measurement covariance, and the average failure rate of the sensor network, will be varied, and the mean convergence time of the LMVUE bank over many simulations will be calculated. Once a pattern in the convergence time is extracted from the sample system, the student will attempt to generalize the results for other systems using concepts in [3].

REFERENCES

[1] Hounkpevi, F.O.; Yaz, E.E., "Estimation for Random Sensor Failure with Unknown Failure Rate," in *Forty-Fourth Annual Allerton Conference, 2006*, Sept. 2006.

[2] F.O. Hounkpevi, "New Approaches to State Estimation in Sensor Network Systems with Uncertain Sensor Measurements," Ph.D. dissertation, Electrical and Computer Engineering Department, Marquette University, Milwaukee, WI, 2007.

[3] Brian D. O. Anderson and John B. Moore, "Optimal Filtering," pages 267 – 288, Prentice Hall, Inc., 1979.

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Chapter Events Calendar

April 14, 2016
Sigma Xi Poster Session – "Advances in the Sciences"
Marquette University Dental School 4:00 pm – 5:30 pm
Sigma Xi Annual Meeting and Dinner, 6:00 pm – 7:30 pm

October 2016
Sigma Xi Mini-Symposium, to be arranged

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