Proceedings of the
Forward Thinking Poster Session/
Colloquy Presentation

Alumni Memorial Union

December 7, 2010

Forward Thinking Poster Session/Colloquy Presentation
Past Award Recipients

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; 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; Brooke Rogers

Contribution of the Frontal Lobes to "Successful Aging"
> Dr. Kristy A. Nielson, Associate Professor and Chair, Psychology; 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; Robert Stone

What's the Best Rehabilitation Prescription? Identifying factors that enhance recovery of gait after s troke
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> Dr. Lisa Hanson, Associate Professor, Nursing; 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; Meetalee Dalal

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> Dr. Astrida Kaugars, Assistant Professor, Psychology; 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; Colleen Willenbring and Kaye Wierzbicki

Role of CamKinase Alpha in Renewal and Reinstatement of Fear
> Dr. Matthew J. Sanders, Assistant Professor, Psychology; Jocelyn Miller

Imaging of the Human Brain during Pedaling
> Dr. Sheila Schindler-Ivens, Assistant Professor, Physical Therapy; Jay Mehta

2005

Cross-Cultural Development and Testing of the Risk Information Seeking and Processing (RISP) Model
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Neurotoxicity of BMAA in Cortical Cultures
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PROJECT TITLE: Peer Interaction in Social Justice Learning Communities: A Form of Support?
FACULTY NAME: Jody Jessup-Anger, Ph.D., assistant professor, Educational Policy and Leadership
STUDENT NAME: Brianne Johnson, graduate student, College Student Personnel Master's program

INTRODUCTION

Living-learning communities attempt to create seamless learning environments to cohere and reinvigorate undergraduates' educational experience. In these communities, students "(1) live together on-campus, (2) take part in a shared academic endeavor, (3) use resources in their residence environment designed specifically for them, and (4) have structured social activities in their residential environment that stress academics" (Inkelas, Zeller, Murphy, & Hummel, 2006, p. 11).

Although researchers tout many academic (Inkelas & Weisman, 2003) and involvement (Pike, 1999) gains for students in living-learning communities in comparison to their traditional residence hall peers, in recent years researchers have begun to critically examine the taken-for-granted benefits of living-learning community participation. Cox and Orehovec (2007) explored student-faculty interaction in these environments and discovered that although virtually all students interacted with faculty on a regular basis, for the majority, these interactions were surface-level. Another taken-for-granted aspect of living-learning community participation is peer interaction. Several quantitative studies illustrated that students in living-learning communities are more likely to interact with their peers than non-living-learning community students (Inkelas & Weisman, 2003), but that sometimes these interactions depend on the focus (Inkelas & Weisman, 2003) and comprehensiveness (Wawrzynski & Jessup-Anger, 2010) of the community. Although the quantity of peer interaction is well documented, the nature of peer interactions is not. Anecdotal evidence suggests that for some students, living and learning with peers may help to integrate their learning in the classroom with their lives outside of class. For other students, however, the close-knit community may serve to alienate them when a conflict arises, which in turn can affect students' learning space, in addition to their living space and peer relationships. For students in social justice or civic engagement themed communities, interactions with peers may be especially instructive, as students may or may not demonstrate the ability to translate civic learning in their classroom environment to civic behavior with their peers.

SIGNIFICANCE

The intent of this qualitative study is to explore peer interaction in living-learning community environments, paying particular attention to 1) How students describe and make meaning of their peer relationships in their classes, co-curricular experiences, and day-to-day lives; 2) How students describe and deal with conflict; and 3) How the social justice orientation of these living-learning communities inform affects their understanding of community. By gaining a better understanding of students' peer interactions, faculty and administrators will be better equipped to handle conflicts that may arise when students reside and take courses together. Furthermore, by knowing more about the nature of peer interactions, faculty and administrators can create and adjust pedagogical practices to maximize the benefits of peer interaction.

FORWARD THINKING/INNOVATION

This study is innovative because it challenges the taken-for-granted benefit of peer interaction in living-learning community participation to develop a deeper, more nuanced understanding of the role of peers in learning. Furthermore, the study will examine the roles whether and how themes of social justice and civic engagement progress from being taught in courses to actualized in the community.

STUDENT INVOLVEMENT

Brianne Johnson will play an instrumental role in recruiting participants, interviewing, coding, analyzing, writing, and disseminating results. Her involvement in the project will complement her coursework in the College Student Personnel master's program.

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PROJECT TITLE: "Challenging behaviors: Parent and hospital staff experience of children with Autism Spectrum Disorder"
FACULTY NAME: Norah Johnson, PhD, RN, CPNP, Assistant Professor, Nursing
STUDENT NAME: Dana Rodriguez, MSN, RN, CPNP, Nursing Doctoral Student

INTRODUCTION

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder marked by qualitative impairments in social interaction and communication, and restricted, repetitive, and stereotypical pattern of behavior, activities and interests [1]. ASD may affect as many as 1out of every 10 Americans [2]. Symptoms of ASD appear before the age of three years old [1]. The term 'spectrum' represents the range of symptom severity in the three disorders: Autistic Disorder, Pervasive Developmental Disorder, not otherwise specified (PDD-NOS), and Asperger's Syndrome [3]. Stereotypies, compulsions, and self-injuries are most severe with Autistic disorder [4] while Asperger's syndrome is the least severe. Children with ASD with their characteristic sensitivities to loud noises and touch, and usual fears, can be easily frustrated, moody, and easily over stimulated [5] in fast-paced, noisy hospital environments. Standardized tools are available for diagnosing ASD, quantifying repetitive behaviors, and mealtime behaviors. However, there is a no standardized observational assessment tool to measure the number or severity of the challenging behaviors of children with ASD in the health care setting.

SIGNIFICANCE

The sensory challenges and trouble adapting to a new routine, characteristic of children with ASD, may provoke challenging behaviors such as temper tantrums that may result in them being labeled as noncompliant or a behavioral problem by health professionals. This issue is also significant because children with ASD require more outpatient healthcare visits, more time during physician visits, and have more medications prescribed than other children, adding both costs and time to their healthcare expenses. An intervention is necessary to decrease these challenging behaviors, decrease the length of ASD child's healthcare appointments, and ultimately reduce the social and economic cost of care for ASD children. In order to develop such an intervention, a valid and reliable standardized assessment tool is needed to accurately measure the outcome behaviors of ASD children. Yet such an assessment tool does not exist. This study will provide a better understanding of the behaviors of hospitalized ASD children, from the perspectives of both the parent and health care providers and inform the development of an observational assessment tool to measure specific behaviors of ASD children in healthcare settings.

FORWARD THINKING/INNOVATION

There is a gap in the literature related to the behaviors of children with ASD in medical setting from both the parent and the health care provider perspective. A qualitative study that captures the medical setting experience for children with ASD and their parents would inform the development of a standardized behavioral observation assessment tool. This tool would allow careful measurement of behavioral outcomes in future studies designed to test interventions to decrease challenging behaviors, decrease the length of healthcare appointments, and reduce the time and costs of care for ASD children.

STUDENT INVOLVEMENT

Dana Rodriguez, MSN, RN, CPNP, a practicing pediatric nurse practitioner, and a second semester doctoral student, is a co-investigator on this project. She completed the literature review, and will develop the focus group questions, and recruit the focus group of health care provider participants (n=5-8). Norah Johnson will be the principal investigator, develop the focus group questions, recruit the focus group of parents of children with ASD (n=5-8), and lead both 2-3 hour focus groups. Focus groups will be audio recorded, and transcribed, and analyzed for themes. This collaborative project will promote Dana's program of study as we have plans for future work using the behavioral assessment tool.

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PROJECT TITLE: "The Halo Effect of Faith Communities: An Exploratory Study on Crime and Religious Social Capital"
FACULTY: Noreen Lephardt PhD, Economics Department
STUDENT: Brenden Mason, MSAE Student

INTRODUCTION

The primary focus of this pilot study is to explore whether there is a significant *spacial* relationship between the location of criminal activity in Milwaukee neighborhoods and the presence religious congregations[1]. The underlying theoretical questions is whether the religious social capital of a congregation (and the influence it has in the neighborhood) has a mitigating "halo effect" on the level and type of crime within the "boundaries" of the faith-based institution. Additionally if there is such a "halo effect" what are the characteristics of the congregations that explain the effect. Many studies recognize the complexity of the influence between congregations and the community [2] however we have found only one study [2] that addresses location and crime using a spacial model. We will use ArcGIS (mapping software) to locate crime and the congregations, and then use spacial regression modeling to evaluate whether there is a statically significant *interactive* relationship between them.

SIGNIFICANCE

The Socio-economic Analysis [4] of the City of Milwaukee reflects the multitude of complex social problems experienced by a significant portion of the population in inner city neighborhoods. This study is significant because it seeks to evaluate the *asset* of the presence of faith based institutions in communities as a part of the solution to urban deterioration. We are currently collaborating with the Milwaukee Police Department, The Interfaith Council of Milwaukee and the Non Profit Center of Milwaukee to obtain data that will be converted into GIS data files to begin the study. Community religious leaders that we have spoken with are very enthusiastic about the study and have pledged their support. Additionally, we see the potential for an on-going research project that studies the more complex influences between congregations and their impact on urban revitalization.

FORWARD THINKING/INNOVATION

This study is innovative because it employs an empirical method (GIS Mapping and spacial regression modeling) that only one other study has used to evaluate whether there is a safe "halo" around congregations. More important however is the potential of this study as a source for Marquette student involvement in research and interaction in the community. If there is a relationship between congregations and crime, further research is implied including studies based on survey-based data collection on the assets, and specific demographics, of a congregation. This type of data collection at the micro level (including asset mapping) would add a dimension to our analysis that is not present in any of the literature we have reviewed. Currently there is only one other study that we can find that uses spacial regression modeling to evaluate Crime and Congregations; and the authors clearly recognized the limitation of their study because they did not have additional assets and demographic information of the congregations [3]. The continuation and evolution of this research would be an opportunity for students and faculty to be involved in the MU's urban mission of civic involvement.

STUDENT INVOLVEMENT

Brenden Mason is a MSAE graduate student and he will be running the spacial regression models for the study. Along with Dr. Lephardt, Mr. Mason is currently meeting with the religious leadership in order to get buy in for the survey portion of the study. Dr. Lephardt and Mr. Mason will present the results of their study (when completed) at the Wisconsin Economics Association Meetings. If the project evolves and we obtain funding, Dr. Lephardt will submit this for the Honors Research Couse.

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Marquette University
Forward Thinking Poster Session/ Colloquy Presentation

PROJECT TITLE: A mouse model of PTSD: Exploring critical developmental and neurobiological factors
FACULTY NAME: Matthew J. Sanders
STUDENT NAMES: Henry Boeh; Sheryl Stevens

INTRODUCTION

Stressful experiences alter associative learning, including Pavlovian conditioning of aversively motivated behaviors. Stress enhancement of fear learning has been proposed as a laboratory model for anxiety disorders and indeed shows many similarities to the human condition [9]. In a recent paper, we reported that stress enhancement of fear learning is dependent upon sex [10]. Sex differences abound in human anxiety disorders as well [8]. We recently completed a set of studies aimed at delineating the impact of development on the stress effect. We expected that animals would be particularly susceptible to stress and stress-inflated fear, during the early "juvenile" period. In fact, juvenile mice demonstrated an impressive resistance to the impact of stress on fear. Younger mice did demonstrate an effect of stress on anxiety but, notably, no effect on fear. While contrary to predictions, these findings add to our knowledge of factors in the stress/fear nexus and can be exploited to focus our search for the neural mechanisms of stress and fear. Normal levels of fear acquisition and expression are dependent upon adequate functioning in limbic structures (notably hippocampus and amygdala). Stress-induced plasticity in these brain areas might underlie inflated fear after chronic variable stress. These areas are susceptible to stress [7,11] and have been implicated in human anxiety disorders as well [4,6].

SIGNIFICANCE

The ability of stress to enhance fear has been proposed as a model for Post-Traumatic Stress Disorder (PTSD; [9]). Abnormal fear responses, both unconditional and learned, are associated with PTSD [1,5]. Stress exposure likely changes excitability and plasticity in brain nuclei critical to defensive learning and behavior. The current set of studies is aimed at understanding the molecular and circuit mediators by which stress exposure changes fear responses. The studies take advantage of the rather specific findings we have accumulated to date, regarding sex and developmental influences. Our search for the underlying neurobiology should focus now upon neurophysiological processes that are a) engaged by both anxiety and fear, b) engaged differently in males and females, and c) engaged differently in juveniles and adults.

FORWARD THINKING/INNOVATION

This study aims to investigate potential physiological mechanisms of fear enhancement by chronic stress. The most obvious first target in this search is the stress hormone corticosterone. Corticosterone is released in response to stress [7], demonstrates profound differences between the sexes [2] and is implicated in fear learning and memory [3]. Thus, the most parsimonious explanation for the stress enhancement of fear is that stress dysregulates a corticosterone response that is critical for fear. The ultimate mechanism, however, might lie further along in the signaling pathway. Therefore, the second target will be corticosterone receptor mechanisms within the amygdala and hippocampus. We will measure the corticosterone responses of male and female mice during stress exposure, fear conditioning, and fear expression. We will then look for changes in corticosterone receptors, in the brain.

STUDENT INVOLVEMENT

Henry and Sheryl will be involved in design, implementation, analysis, and publication. Their work was critical to our present understanding of sex and developmental factors. The developmental studies comprised their Master's theses and the future work will be integral to their doctoral work.

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Colloquy Abstract

Project Title: "Revisiting Niche Theory: Interest Organizations and their Environment"
Faculty Name: McGee Young, PhD, Assistant Professor, Department of Political Science
Student Name: Holly Flynn-Piercy, Political Science Masters Student

INTRODUCTION

Interest group scholars have appropriated the idea of a 'niche' to describe the political context within which advocacy takes place. Despite widespread adoption of this term, the definition of a niche remains somewhat ambiguous. Specifically, scholars alternately refer to an 'issue niche', (Browne 1990) an 'interest niche,' (Baumgartner and Leech 2001) or an 'organizational niche,' (Gray and Lowery 1996) without clearly specifying the differences in these terms. This ambiguity creates a barrier to developing a strong theoretical core within the neopluralist (Lowery and Gray 2004) paradigm, as these three different conceptions of 'niche' have theoretically dissimilar roots. For example, a scholar who is referring to an issue niche is describing a much different phenomenon than one who is referring to an interest niche. This paper aims to unpack the concept of a niche in addition to conceptualizing how groups interact at different 'niche levels', in order to provide theoretical clarity and guidance to the field. In doing so, it assimilates a broader literature on the institutional characteristics of policy networks.

SIGNIFICANCE

Baumgartner et al. (2008) ignore the impact of interest group niches in their pathbreaking study of interest group influence. They want to know whether interest groups influence policymaking; we want to know why certain groups and not others are influential. Why, for example, is the Sierra Club a more effective advocate than Greenpeace? As such, it is the intent of this project to provide scholars with a new way of thinking about the concept of a 'niche' and its relevance for the interaction between interest groups and policymaking in Washington. Using data from the Baumgartner et al. *Advocacy and Public Policymaking Project* (1999-2003) and the *Policy Agendas Project* (1947-present) this study will focus on several specific issues to identify how groups lobbying on an issue like the environment operate within at different levels of a 'niche'. In other words, how do interest groups lobby within and interact between organizational, interest and issue niches?

FORWARD THINKING/INNOVATION

This study is innovative because it seeks to formulate a new conceptualization of interest group niche theory. Using this newly released data, we expect to dramatically change the debate over interest group lobbying reform. Rather than a one-size-fits-all reform effort, we will show that different groups are influential for different reasons. These reasons are grounded in the placement of a group within a particular set of niches. Thus a reform that works for one group may be entirely ineffective for another group. We expect this research to appeal to a wide variety of scholars working on policymaking, but also to foundations and think tanks whose work centers on governmental reform.

STUDENT INVOLVEMENT

Holly Flynn-Piercy will be responsible for data collection and analysis with the support of and in collaboration with Dr. McGee Young. Using this colloquy presentation as a starting point, it is the intention to present this paper at the Midwest Political Science Association (MPSA) conference in Chicago in April 2011.

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PROJECT TITLE
The Amader Gram Breast Care Palliation Study: Phase 1
FACULTY
Sheikh Iqbal Ahamed Ph.D.

STUDENTS
Ferdaus Ahmed Kawsar, Mohammad Tanviruzzaman, Md. Munirul Haque, Mohammad Adibuzzaman,

INTRODUCTION

In Bangladesh, 90 percent of the estimated 20-25,000 women diagnosed with breast cancer die from it [1]. One important reason behind this high death rate is absence of low-cost continuous treatment and monitoring. Breast cancer patients in advanced stage of the disease need palliative care as well as traditional treatment. Reducing the suffering and improving the quality of life might be the best possible alternative for such patients. In this paradigm, long term care needs to be provided through an adaptive feedback-oriented treatment mechanism. To this end, it is essential to assess patients regularly and if needed, adjust the interventions according to feedback without delay. Doctors need to monitor these advanced stage patients to adjust interventions based on objective regular feedback from them. But it is very difficult for these advanced stage patients to visit health centers with enough frequency, especially who are from remote area.

SIGNIFICANCE

24.3% female cancer patients suffer from breast cancer [2]. At present there are only 98 oncologists in Bangladesh [2]. Health-care facilities are scarce in a developing country like Bangladesh. National Institute of Cancer Research and other hospitals can provide treatment to only 2% of all cancer patients per year (20,000 out of 1 million) [2]. Other socio-economic factors become decisive in how regularly a female patient can visit the facility in person. An assessment system that can monitor the patient's health status regularly without requiring her to visit the health-care facility in person will be of great value. Fortunately, in Bangladesh, like many of the low-income countries, cell phones have become ubiquitous. According to [3], the number of cell phone users in Bangladesh reached 50.4 million by Aug 2009. Cell phones along with a body-area sensor network of small, wearable sensors can serve as a low-cost and suitable system for regularly monitoring a patient's health-status without requiring her to visit the health-care facility. The research results from this project can be used for patients in other areas.

INNOVATION

The goal of this research is to develop a low-cost cell phone based integrated system that will provide objective feedback to healthcare personnel that will help them to decide the nature of intervention. The objectives of phase I are as follows:

- Develop cell phone based Edmonton Symptom Assessment Scale (ESAS) both in English and Bengali.

- Using cell phones and sensors, design and develop a system that automatically,

    o Detects and quantifies pain, anxiety, and depression from facial expression

    o Analyze the sleep pattern of the patient

    o Measures the amount of verbal interactions of the patient is engaged to.

    o Quantifies the fatigue of the patient

    o Measures physical activity of the patient within a certain time-interval

STUDENT INVOLVEMENT

Kawsar and Adibuzzaman are working on building a system that will recognize different physical activities. Mohammad and Haque are working to develop a system to detect pain level from facial expression.

REFERENCES

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[2]http://english.ohmynews.com/articleview/article_view.asp?menu=c10400&no=335342&rel_no=1
[3]http://en.wikipedia.org/wiki/List_of_countries_by_number_of_mobile_phones_in_use

PROJECT TITLE

CADD: A Combined Approach to Determine Drunken Driving

FACULTY
Sheikh Iqbal Ahamed, Ph.D.

STUDENT NAME
Md. Munirul Haque, Mohammad Adibuzzaman, David Polyak

INTRODUCTION

Driving Under Influence (DUI) is one of the top six causes for fatal crashes as identified by the National Highway Traffic Safety Administration (NHTSA). According to NHTSA, out of 37,261 people died in traffic crashes in 2008 in the United States, roughly 11,773 people died due to crashes involving alcohol-impaired driving. Thus drunken driving is accounted for 32% of all traffic deaths in 2008, that is, on average someone is killed in an alcohol-impaired driving crash every 45 minutes in the U.S. This one statistics is enough to give the range of worrying picture that demands a crying attention. Right now there is no facility that can help the drunk drivers in terms of warning or so on. Sometimes they are caught by police and goes for sobriety test but most of the times that becomes too late. This indicates that we are in need of a system that will restrict or warn the drunk drivers in the first place. Hence an automated system that could detect drunkenness and alert the driver or truck dispatcher could save many lives.

SIGNIFICANCE

This system would alert the drunk drivers and warn them. This would create awareness and thus avoiding possible crashes. The system will be working as the first of its kind that will act to omit the possibility of an accident before it actually happens.

FORWARD THINKING/INNOVATION

We tried to combine both physical and facial evidences under the umbrella of the proposed system. The total system includes three major phases. The first phase will identify about the drunkenness of the person from his gait pattern. Unsteady gait, poor coordination, and disorientation are three notable characteristics for drunken people. We will be using the accelerometer and gyroscopes available in the current mobile phones for this purpose. We have already developed a system named epet to uniquely identify a person from his/her gait pattern. Research issues involve not only identifying an unsteady gait pattern but also making sure that specific pattern evolved due to drinking. Slurred speech is another notable symptom. Voice recorders of mobile phones can be used for this purpose. A mobile based system will compared the recorded speech of the person and automatically identify by inputting the recorded speech in a neural network based classification approach. The neural network will be trained by samples of slurred speeches and will be able to classify any input into drunk or not drunk category. Finally, in 2008, 68% of drivers involved in alcohol-impaired driving fatalities had a Blood Alcohol Concentration (BAC) level of 0.15 or higher [1] – a trend that has remained relatively unchanged for more than a decade. NIAAA scientists have come up with a chart [2] coupling changes in feelings and personality with BAC. According to that, subjects feel pleasure, numbness of feelings, nausea, and sleepiness when the BAC level is 0.06-0.10. For a BAC level of 0.11-0.20 there come anger, sadness, and mania. These feelings can be detected using video analysis or image analysis. Along with that ruddy facial features and a bloated face are often evident with alcoholism. We are considering the BAC level starting form 0.06 since a BAC level with 0.08 or higher is considered as alcohol-impaired driving. Since 2002, driving with BAC level 0.08 or more is considered as an offense named "illegal per se". We have already developed an inexpensive model based on popular Eigenface method to detect several facial expressions from facial image including sadness, anger, joy, and sleepiness. We plan to extend that model to classify the drunk or not drunk scenario. Along with that we plan to deploy an empirical study where drunken subjects will drive in simulated driving environment. A video camera will record the facial expression of the subjects and give us important features about the facial symptoms of drunken drivers. We will also analyze whether there is any special issues when they crash in simulated environment.

STUDENT INVOLVEMENT

Munirul Haque is working on design issues of the proposed framework. Mohammad Adibuzzaman, and David Polyak will help in developing the entire system and evaluate its performance..

REFERENCES

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PROJECT TITLE
iFactotum: Sensor-rich iPhone as a Versatile Tool
FACULTY
Sheikh Iqbal Ahamed, Ph.D.

STUDENTS
Mohammad Tanviruzzaman, Casey O'Brien

INTRODUCTION

Smart phones are increasingly being equipped with motley built-in sensors like camera, GPS, accelerometer, gyroscope, and magnetometer. People are using smart phones everyday to meet various ends like, doing voice communication, sending and receiving emails, doing map based geo-navigation, managing daily schedules etc. Being in constant day-to-day company of its user, a smart phone has the potential for helping him sensibly (using sensor-data) in numberless ways. Our vision is to use the iPhone 4 as an all round handy tool and to that purpose we have presented the idea of three applications: for measuring length and surface-inclination ("Measure"); for measuring user's daily physical activity level ("Spirit"); and for automatic revealing of the indoor map of a building and infrastructure-less indoor-localization of the user ("Seeker"). Though iPhone 4 is now the only smart phone that supports full nine degrees of freedom inertial sensing, it is expected that in no time other phones will also include accelerometer, magnetometer, and gyroscope, which clearly indicates the wide-ranging impact of our vision.

SIGNIFICANCE

The umbrella term "iFactotum" unites the three applications under the broad vision: it is now possible to use the iPhone 4 as a general-purpose tool alongside its usual usage. People often need to measure lengths, e.g., to buy furniture it is handy to be able to measure the length or width of the item of choice and compare it with the width of the doors in the house. Our first application "Measure" will let its user to do just that. Besides, "Measure" will work as an ADA (Americans with Disability Act 1990) Toolkit on the phone. Our second application "Spirit" will determine the daily activity level of the user, e.g., how much the user walks during a day. Daily activity level is a well-recognized sign of one's health status. The activity level also indicates how a wound is recovering or for a dementia patient - how his behavior is changing. Lastly, "Seeker" will reveal the indoor map of a building and locate the user indoors in real-time without the help of any external infrastructure. Indoor localization is a pressing problem and its solution has profound impacts, e.g., an organization can optimally set its employees for better output or it can optimally switch on and off the power lines of different parts of its buildings to save power consumption; if it has a way to analyze the location and movement patterns of the employees in real time.

INNOVATION

No available iPhone application, for making measurements, utilizes the phone's orientation (available from its gyroscope) and thus their output is hopelessly erroneous when the user moves the phone through air from the starting to the ending point. "Measure" will perform dead reckoning based inertial navigation [1] through the measurement-distance and will incorporate the changes in the phone's orientation while calculating the length: the idea is to project acceleration vectors onto a global reference frame using the phone's orientation before performing integrations to get the speed and the position. "Spirit" counts the periods present in the accelerometer signals due to various activities of the user and translates those counts into a measure of daily energy expenditure by multiplying with pre-computed conversion factors [2]. "Seeker" counts the steps (using accelerometer) and gets the direction of movement (from magnetometer and gyroscope) of the user and reveals the indoor map of the building by analyzing the navigation traces of many employees. Once the map is at hand, the same method is applied for real-time tracking of the user. Sensor-noise and different bodily placements of the phone are the problems we address in general.

STUDENT INVOLVEMENT

Tanvir is doing analyses on the accelerometer, gyroscope, and magnetometer signals of iPhone 4 and designing filters to reduce sensor-noise. He is also implementing the required algorithms on the iPhone 4. Casey is collecting data for evaluating the work.

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PROJECT TITLE

A reliable batch-mode search technique for computational RFID tags

FACULTY

Sheikh Iqbal Ahamed, Ph.D.

STUDENT NAME

Farzana Rahman

INTRODUCTION

The past decade has seen significant effort and progress towards the original ubiquitous applications. Particularly wireless sensor networks (WSNs) based on mote sensing platforms have been applied to many real-world problems. Due to low power design and careful networking protocols these sensor networks had lifetimes measured in weeks or months, which were generally sufficient for the applications. However, the size and finite lifetime of motes make them unsuitable for many other applications. For the last few years, it is argued that Radio Frequency Identification (RFID) technology has a number of key attributes that make it attractive for such applications. RFID is a technology for automated identification of objects and people. But future RFID applications will require tags that can also perform minimal sensing, computation, and storage. One recent extension of RFID, Computational RFID (CRFID), presents exciting possibilities for ubiquitous computing applications. CRFID combines the advantages of RFID with those of sensor networks. The Wireless Identification and Sensing Platform (WISP) from Intel Research Seattle [1, 2] is an instance of CRFID. WISPs combine passive UHF RFID technology with traditional sensors. WISPs have the capabilities of RFID tags but also support sensing and computation. To an RFID reader, a WISP is just a normal EPC class-1 or gen-2 tag; but inside the WISP there is a 16-bit general purpose microcontroller. The microcontroller can perform a variety of computing tasks, including sampling sensors, and reporting that sensor data back to the RFID reader. WISPs can sense quantities such as light, temperature, acceleration, strain, and liquid level.

SIGNIFICANCE

For simple RFID sensor networks, the data of interest is simply each tag's identity. However, for WISP sensor networks, it is difficult to develop efficient protocols for gathering sensor data that changes over time. Currently, WISP tags with new sensor data must wait until they are interrogated by a reader. This increases the likelihood of many WISP tags wanting to use the bandwidth limited channel at the same time when replying to the reader query. Because of this, the trivial RFID protocols securing RFID network cannot be applied to WISP sensor network.

Let's consider a WSN deployed in a battlefield. Quick response time of sensor network along with high data accuracy, integrity, and reliability is very important in such networks. A reader might have hundreds of accelerometer WISPs in its field of view. Because all the WISPs share a single reader channel, the update rate per tag would be very low if every tag were simply queried for sensor data sequentially. At any given moment, the reader may want to find out whether all the tags are present in the battlefield or not. And such a search execution will have to be scalable too. So introducing scalable and secure searching technique is a major goal of this poster.

FORWARD THINKING/INNOVATION

In any practical systems, the number of WISP tags within the system is extensive. Searching a particular WISP tag among this immense number of tags needs to be efficient. Which means that searching of tags need to be scalable. Scalability means that a reader will be able to search a tag with constant computational time regardless of the number of tags that is owned by it. Therefore, rather than searching one tag at a time, our idea is to search bulk of tags or searching all the tags in a batch to increase the efficiency of the system.

STUDENT INVOLVEMENT

As a first step towards addressing the tradeoff between scalability and efficiency of WISP networks, we plan to device a *Batch Mode Search Protocol* using *Threshold Cryptography*. Our key concept is that WISP nodes in the network will share their private data using a secret sharing threshold cryptography scheme. Farzana is working on the design and performance issues of the protocol. She will also conduct a comprehensive literature survey to extract the related works which will be compared to her technique.

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PROJECT TITLE: **"Speech Adaptation for Rehabilitation"**
FACULTY NAME: **Jeffrey J. Berry, Ph.D., CCC-SLP, Assistant Professor, Speech Pathology & Audiology**
STUDENT NAME: **Mary Bolgert, B.S., Graduate Student, Speech Pathology & Audiology**

INTRODUCTION

The broad objective of this line of research is to develop a novel rehabilitation method for the treatment of *dysarthria*; a speech impairment resulting from brain injury characterized by disordered control over movement of the speech organs. This method will exploit the experimental phenomenon of *speech adaptation*, which has become a recent focus in the study of non-disordered speech, but has yet to be studied in disordered speech. The specific aims of the proposed research project are to: 1) further the development of our novel method for eliciting speech adaptation; and 2) use this method to complete the first known study of speech adaptation in individuals with dysarthria resulting from traumatic brain injury.

SIGNIFICANCE

Each year in the United States 80,000-90,000 people survive traumatic brain injury (TBI) with permanent disability[1]. TBI survivors are often children and young adults. One-third of these individuals live with dysarthria. People with severe dysarthria produce speech that is unintelligible to many listeners. Due to the lack of effective treatments, this is a lifelong disability. Our work aims to develop a novel treatment for dysarthria.

The phenomenon of *speech adaptation* refers to experimentally elicited changes in a speaker's tongue, lips, and jaw movements resulting from modifications to the sounds that a speaker hears himself producing[2]. Using a speech synthesizer, researchers change how the subject hears his own speech. This change causes the non-disordered subject to subconsciously alter his speech movement patterns. The altered patterns can be made to persist for a period after the signal modifications end, suggesting that speech can be re-learned. Speakers with dysarthria, despite exhibiting impaired speech movement patterns, do maintain a preserved ability to alter their speech movements. Speech adaptation holds great promise as a basis for rehabilitation. However, existing methods for eliciting speech adaptation use speech synthesis techniques that require high quality speech. Consequently, these methods will not work for subjects with speech disorders.

FORWARD THINKING/INNOVATION

As an alternative to conventional methods for eliciting speech adaption, we propose a speech synthesis technique that requires only a subject's speech organ movements (articulatory speech synthesis), and does not require that the subject be able to produce intelligible speech. Our approach uses a speech movement tracking system, uniquely available at Marquette[3], in conjunction with relatively simple software synthesis model that will work with speakers with dysarthria. The tracking system is portable and of reasonable cost for use in common clinical settings. The system uses small sensors to track movements of the subject's tongue, lips, and jaw. The movements are conveyed to a software-based articulatory speech synthesizer that generates an audible signal based on the subject's real-time tongue, lip, and jaw movements. The sound signal from the synthesizer is routed back to the subject through earphones. The subject hears only the synthesized speech, not his own voice. By changing synthesizer parameters, we can systematically modify how the subject hears his speech, triggering subconscious changes in the movement of his tongue, lips, and jaw. The proposed work will further development of our innovative approach and use it to assess speech adaption for subjects with TBI related dysarthria and comparable healthy controls. This work will form the basis for a novel approach for the rehabilitation of dysarthria.

STUDENT INVOLVEMENT

Mary Bolgert, B.S., will be responsible for recruiting and screening TBI subjects and healthy controls. Ms. Bolgert will administer standardized tests of speech intelligibility and cognitive-linguistic function in order to screen prospective participants. Extensive screening of TBI survivors is critical to control for factors that may affect speech adaptation[4]. In addition to Ms. Bolgert's effort, a Senior Design Program team is currently working on software development for this project. This team of 5 engineering and computer science students aims to complete basic programming needs for the initial speech adaptation experiments by May 2010.

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Abstract

Project Title: "The Effect of Light Cure Initiation Time on Orthodontic Bond Strength with a Resin-Modified Glass Ionomer"

Faculty Name: Dr. David Berzins, PhD, Graduate Program Director of Biomaterials

Student Name: Dr. Jess Thomas, BS, DDS, Graduate Orthodontic Resident

Introduction:

Resin modified glass ionomers were first introduced in the late 1980's as an attempt to improve the mechanical properties as well as the moisture sensitivity of previous glass ionomer cements. They consist of a mixture of glass ionomer and composite resin cements. The glass ionomer component consists of polymers of polyacrylic acid and flouro-aluminosilicate bases which have undergone an acid-base reaction. This material alone has properties that allow it to chemically bond to tooth structure, but has low early bond strength and is sensitive to moisture. The composite resin material consists of dimethacrylate monomers with ceramic filler particles, which set primarily from a light polymerization reaction. This material by itself exhibits high micromechanical bond strength to tooth structure, but is subject to degradation. Resin modified glass ionomers consist of photoinitiators, flouro-aluminosilicate glasses, polyacrylic acid, water, and a water soluble methacrylate monomer. These resin modified glass ionomers are able to release fluoride and can chemically bond to tooth structure much like the earlier glass ionomers, but also have the characteristics of the composite resins, such as increased bond strength to tooth structure. Because this material exhibits the properties of both the glass ionomers and the composite resins, they set by both acid-base and photo polymerization reactions.

Significance:

Resin modified glass ionomers set by at least two reactions dependent upon reactants diffusing through the matrix. The purpose of this study was to evaluate whether differing the light polymerization reaction initiation at different time intervals would alter the reactions interaction, and therefore effect the strength of the resin modified glass ionomer, and potentially the bond strength of orthodontic brackets. The thought is that with a longer time to light cure, the initial acid-base reaction becomes more predominant and the majority of the material is set under through that reaction resulting in a differing structure, then if the material were to be cured immediately. This conversely would result in a material set mostly to light polymerization, and therefore resulting in a material of differing structure from the material set mostly by acid-base reaction. We will be utilizing DSC to analyze exothermic reactions of both the acid-base reaction, as well as the light polymerization reaction to determine how one reaction may compete or inhibit the other, and how this may alter the composition of the material, and ultimately, the bond strength of the material.

Forward Thinking/Innovation:

This study will allow the clinician who utilized resin modified glass ionomer cements to bond orthodontic brackets, to better understand how waiting to light cure a bracket after positioning may influence the potential bond strength of the bracket to the tooth, and thus to possibly prevent incidental debonds during treatment.

Student Involvement:

Dr. Jess Thomas will be the primary investigator on this study, with the support and collaboration of Dr. David Berzins. Dr. Thomas will collect approximately 80 extracted virgin, noncarious, nonfractured teeth from individuals who required routine extractions for specified dental reasons other than the participation in research. These teeth will be divided into 4 groups of 18, with 5 teeth being utilized for method testing. Each group will be assigned a predetermined time interval in which a standard orthodontic bracket will be cemented on the buccal surface of the tooth with a resin modified glass ionomer cement, and light cure intiation will take place. The bond strength will then be tested by determing the necessary force needed to debond the bracket from the tooth. Dr. Thomas and Dr. Berzins will then analyze the Data to determine if the time interval from bracket placement to light cure initiation of the resin modified glass ionomer changes the bond strength of the bracket to tooth interface.

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PROJECT TITLE: "Force decay of esthetic, fiber-reinforced composite orthodontic wires"
FACULTY NAME: David Berzins, Ph.D., Associate Professor, Dental Biomaterials
STUDENT NAME: Ju-Han Chang, D.D.S., first year orthodontic resident

INTRODUCTION

Fiber-reinforced composite has been used in dentistry for at least 30 years. It has been utilized in many areas: in prosthodontics for fixed partial dentures, in endodontics as posts and cores, in periodontics for periodontal splinting, and in oral surgery for trauma stabilization.[1] With the increasing esthetic demands, fiber-reinforced composite has also been used to replace metal wires in orthodontics. Some passive applications are bonded lingual retainers and bonded pontics replacing missing lateral incisors.[2] As an active application, research has shown that fiber-reinforced composite can replace stainless steel wires to join segments of teeth together as an anchorage unit.[2,3] Taking active application one step further, fiber-reinforced composite archwires have been utilized in clinical trials.[4] In order to choose the right wire to meet individual patient's needs, the properties of these new fiber-reinforced composite wires need to be carefully studied.

SIGNIFICANCE

Increasingly, adults seeking orthodontic treatment demand more esthetic orthodontic appliances. Hence, ceramics and polycarbonates are successfully utilized to produce clear brackets.[5] Esthetic wires, such as fiber-reinforced composite, have been developed to be used in conjunction with clear brackets to obtain ultimate esthetic results. The fiber-reinforced composite's translucent optical property definitely meets the esthetic demand of the patients. However, studies needs to be conducted to see if it also has the desired mechanical properties for clinicians to utilize it in active orthodontic treatment. The goal of this research is to study the force decay levels of fiber-reinforced composite archwires from BioMer and compare it to that of conventional nickel-titanium (Nitinol Classic from 3M Unitek) archwires using a three-point bending test.

FORWARD THINKING/INNOVATION

To the best of our knowledge, we are the first to explore the force decay level of fiber-reinforced composite archwires from BioMer. To do so, we will take different sizes of composite archwires and perform three-point bending tests with different amounts of deflection. Then we will measure how much force is needed to maintain that amount of deflection over time. We will use Nitinol Classic from 3M Unitek as the control for comparison purpose.

STUDENT INVOLVEMENT

Ju-Han Chang (first year resident in orthodontics) will participate in this project which will become her thesis leading to Master's degree. She will completely be involved in designing and implementing experiments, analyzing data, and writing the research paper.

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ABSTRACT

PROJECT TITLE: "Friction Testing of a New Ligature"
FACULTY NAME(S): David Berzins, Ph.D. Assistant professor, General Dental Sciences. Graduate Program Director for Dental Biomaterials.
STUDENT NAME(S): Alison Mantel, DDS. Orthodontic graduate student.

INTRODUCTION

For teeth to successfully slide along an archwire, a certain force is required. This includes the force to move teeth and the force to overcome the friction that is present. In this situation, friction is due to a combination of chemical and mechanical factors. It is important to maintain low forces in orthodontics to maintain the position of the anchor teeth, keep reciprocal forces low, increase patient comfort, and reduce the risk of root resorption. Thus it is desirable to have a ligature that creates as little friction as possible to decrease the amount of force needed for the wire to slide along the bracket.

SIGNIFICANCE

Since this is a new ligature not yet introduced to the market, it is important to have a scientific study available to practitioners considering using this product. This will allow them to make an informed decision as to whether this ligature has clinical benefits in comparison to their current ligature being used in practice.

FORWARD THINKING/INNOVATION

This study is innovative because it recognizes the difficulty that practitioners have in determining which materials are best to use in their practice. The market has been flooded with many materials, devices and recommendations from manufacturers. Comparisons of products allow orthodontists to make informed decisions based on scientific research so that they can better the treatment given to their patients.

STUDENT INVOLVEMENT

Alison Mantel will be leading this project with the assistance and guidance of David Berzins. She will collect .018 inch stainless steel wires cut into 3 ½ cm pieces and 30 stainless steel brackets with 0 degrees of tip/torque. They will then be cleaned with 95% ethanol prior to testing. Each individual bracket will be mounted on a custom metal fixture allowing an aligned wire attached to an opposite fixture to be passively centered in the bracket slot. The wire will be ligated to the bracket using one of five types of ligatures including the low friction test ligature from American Orthodontics, conventional ligatures from American Orthodontics, Sili Ties™ Silicone Infused Ties from GAC, Synergy® Low-Friction Ligatures from RMO, and SuperSlick ligatures from TP Orthodontics. Resistance to sliding will be measured over a 7 mm sliding distance using a universal testing machine (Instron) with a 50 Newton load cell and a crosshead speed of 5 mm/min. The initial resistance to sliding (static) will be determined by the peak force needed to initiate movement and the kinetic resistance to sliding will be taken as the force at 5 mm of wire/bracket sliding. She will run fifteen unique tests for each ligature group. Measurements will be conducted under dry conditions at room temperature. The data will then be analyzed. Mean and standard deviation for all test groups will be determined. Normality of data will be determined: if parametric, statistical analysis will consist of a t-test, if non-parametric, statistical analysis will consist of a Mann-Whitney test. Significance will be set to alpha = 0.05. This study will then be either submitted for publication or written as a thesis to complete Alison's masters degree in orthodontics.

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PROJECT TITLE: "**Systematic review of facial soft tissue measurements in orthodontics**"

FACULTY NAME: Jose A. Bosio, DDS, MS, Assistant Professor, Department of Developmental Sciences/Orthodontics, MUSoD
STUDENTS NAMES: Carolyn Gardiner, Amanda Olejniczak, D-3 Dental Students, MUSoD

INTRODUCTION: Soft tissue facial measurements have been performed for many years to depict orthodontic treatment and growth changes. The evolving new technologies, such as three dimensional technology, has allowed for new ways to record facial measurements as compared to the traditional two dimensional methods. Determining the methods of facial soft tissue measurements and having the ability to compare them will allow the orthodontic profession and researchers to predict and evaluate better treatment outcomes. The purpose of this systematic review research study is to identify the different methods for measuring facial soft tissues and to determine which of these methods is the most accurate and beneficial for using on a regular basis in orthodontic evaluations. **Methods**: An electronic search in three databases (MEDLINE, CENTRAL, EMBASE) will be performed by the authors for clinical studies that addressed the above stated objectives. A list of eligibility criteria will be established to determine inclusion and exclusion criteria for the article. The *Cochrane Handbook for Systematic Reviews of Interventions* will be used as the guideline for this review. **Results and Conclusion:** The authors are currently conducting their search to determine the limits of the research study and, therefore, have not yet determined the inclusion criteria, results, or conclusions.

SIGNIFICANCE: By defining the best methods to acquire facial measurements, the authors intend to validate procedures used in other studies conducted in our institution and around the world, as well as define the most reliable facial measurements to conduct research in the area of orthodontics.

FORWARD THINKING/INNOVATION: A systematic review study on the methods to measure soft tissue structures has never been performed. Thus, it is our intention to get acquainted with the methods of soft tissue measurements used in as many studies as possible, respecting the study inclusion/exclusion criteria.

STUDENT INVOLVEMENT: Carolyn and Amanda are third year dental students who will participate in this project, leading them to publish a systematic review paper. Their involvement in the design and literature search, analyzing data and writing the systematic review will be the major source of work for this project. The end result of this process should be a publication in one of the major orthodontic journals.

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Project Title: Agenesis of Maxillary Lateral Incisors in Humans and the Relation to Overall Tooth Size

Faculty Name: Dr. Jose Bosio, Dr. T. Gerard Bradley

Student Name: Jane Wright DDS, Orthodontic Resident

Introduction: Patients with agenesis of one or both maxillary lateral incisors may post significant challenges for orthodontic practitioners. The objective of every orthodontist is to obtain good harmony between the upper and lower jaws with well aligned teeth and good interdigitated occlusion. It has been anecdotally suggested (Kokich 2009) that patients with missing lateral incisors may have a tooth size discrepancy due to the lack of proper dental arches relationship. Thus, the goal of this study is to evaluate if tooth size discrepancy is found in persons who are congenitally missing one or both maxillary lateral incisors. **Materials and Methods**: Forty sets of dental casts from 19 male and 21 female Caucasians (mean age 16.3) were collected with agenesis of one or both maxillary lateral incisors and matched to a similar control group. The mesio-distal dimensions of all teeth were measured with a digital caliper (Masel Electronic digital calipers, Bristol, PA). Data were analyzed to determine if a tooth-size discrepancy exists. **Results:** Maxillary tooth size was smaller on average in the agenesis test group for every tooth; first molar to first molar. However, not all of the tooth-size reductions were statistically significant and there were gender differences in the location. **Conclusions:** Agenesis of one or both maxillary lateral incisors is associated with a tooth-size discrepancy.

Significance If tooth size discrepancy is found, the orthodontists and the restorative dentist will be able to better plan and select the restorative options early into treatment. Usually two orthodontic options are available in these cases: to open it or close the space. The biomechanics used in both options will differ significantly, resulting in different treatment approaches.

Forward Thinking/Innovation Research has indicated that there is a tooth size discrepancy between races[1] and sexes[2] and people with familial genetic mutations[3]. Through clinical experience, it is suggested that there is a discrepancy in tooth size with people that are congenitally missing teeth, especially maxillary lateral incisors. However, few studies have examined such a discrepancy[4]. The goal of this project is to measure the tooth-size dimensions of the dental casts from patients who are congenitally missing one or both maxillary lateral incisors and compare these measurements to a set of controls. These controls will be matched to the study population for gender, age and race to eliminate any other variable.

Student Involvement Dr. Jane Wright was the primary investigator in this project, collecting dental casts of patients from orthodontists in the greater Milwaukee area and from Marquette University School of Dentistry's Orthodontic Department. The dental casts were measured and re-measured to determine the reliability. Dr. Wright will participate in this project which will become her thesis leading to Master's degree. She was totally involved in designing and implementing experiments, analyzing data and writing her research paper.

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ABSTRACT

PROJECT TITLE: "Cephalometric Comparison to Soft Tissue Measurements"
FACULTY NAME: Jose Bosio, DDS, MS, Assistant Professor, Clinic Director, Department of Developmental Sciences/ Orthodontics, MUSoD
T. Gerard Bradley, BDS, MS, Chair/Program Director, Department of Developmental Sciences/ Orthodontics, MUSoD
STUDENT NAME: Nikolay Mollov, DDS, Orthodontic Graduate Student

INTRODUCTION:

Proper orthodontic treatment requires a detailed evaluation of any possible existing maxillo-facial complex problems, including the diagnosis of any soft and hard tissue discrepancies. A cephalometric radiograph is normally used to detect bony discrepancies while the clinical exam and facial photographs are used for the diagnosis of soft tissue problems. To provide ideal orthodontic care it is essential to achieve proper diagnosis for both soft tissue and hard tissue complexes. Thus, establishing a potential relationship between soft tissue and cephalometric landmarks, may give the orthodontist another tool for achieving optimal diagnosis and better clinical results.

SIGNIFICANCE:

Soft tissue problems are diagnosed at the clinical exam and via facial photographs, during orthodontic diagnosis and treatment planning. The cephalometric radiographs can also be used for soft tissue diagnosis. This project will attempt to establish a correlation between proportions in soft tissue facial landmarks and their representation in the cephalometric radiograph.

FORWARD THINKING/INNOVATION:

While research has been conducted on soft tissue facial proportions alone and soft tissue proportions on a cephalometric radiograph, not very many studies examining the relation between the two are found in the literature. This study will attempt to explore the correlation between soft tissue measurements made directly in the patients face and lateral cephalometric radiographs.

STUDENT INVOLVEMENT:

Nikolay Mollov will be leading the investigation under the supervision of Dr. Jose Bosio. Two sets of recordings will be taken. The first will be a set of measurements of the soft tissue structures of the face. They will be recorded during the patient's initial exam in the Marquette School of Dentistry Orthodontic Clinic. The second set of measurements will be done on the lateral cephalometric radiograph taken at the same initial appointment. The two sets of measurements will be recorded in a form. Approximately 40-50 data sets will be collected for the current project. A statistical analysis will be performed on the two data sets attempting to establish any relation between them. This project will serve as Nikolay's masters degree in orthodontics and possibly be published in a referred orthodontic journal.

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Abstract

Project Title: "Assessing eruption in the single-tooth, anterior implant patient"
Faculty Name(s): T. Gerard Bradley BDS, MS, Program Director of Orthodontics, Chair Department of Dental Developmental Sciences
Student Name(s): Kevin Knutson DDS, Orthodontic Resident

Introduction

Implant protheses are at the forefront of dentistry and complicated, interdisciplinary scenarios arise when the growing patient presents with a missing anterior tooth. The timing of surgical placement is of the utmost importance if the patient has future growth. If an anterior implant is placed before growth is completed it will look submerged and be in infra-occlusion over time. This unfortunate scenario leaves the patient with an unesthetic result and an implant crown that may need to be replaced[2].

Significance

Vertical growth in accordance with implant placement is of paramount importance to surgeons, prosthodontists and orthodontists. Variances in eruption of anterior teeth has been described between sexes but there has been little investigation why this discrepancy exists [1].

Forward Thinking/Innovation

This study will use a well established method of superimposition to assess the vertical growth and tooth eruption of patients with missing anterior teeth in addition to other values in an earlier study. Reasons for the difference in incisor eruption between sexes will be explored—an area of research that requires further investigation[1].

Student Involvement

Kevin Knutson will be the lead investigator under the guidance of Dr. T. Gerard Bradley. A population sample must have the following criteria to be included in this study:

(1) Missing an incisor or canine tooth

(2) Between the ages of 12 and 20

(3) Have three lateral cephalometric radiographs taken at pre-treatment (T1), post-treatment (T2) and retention/growth assessment (T3)

(4) All radiographs to be taken on the same x-ray unit

(5) An equal number of male and female subjects

The following measurements in millimeters will be assessed:

(1) Anterior Face Height (AFH) from Nasion (N) to Menton (Me)

(2) Lower Anterior Facial Height (LAFH) from Anterior Nasal Spine (ANS) to Menton (Me)

(3) Eruption of maxillary incisors from the incisal edge of maxillary central incisors (U1) to the Palatal Plane (PP)—a plane formed through Anterior Nasal Spine (ANS) and Posterior Nasal Spine (PNS)

(4) Eruption of the mandibular incisors from the incisal edge of mandibular central incisors (L1) to the Mandibular Plane (MP)—a plane formed through Menton (Me) and Gonion (Go)

The following angular measurements in degrees will be assessed:

(1) Palatal Plane (PP) to Cranial Base (SN)—a plane formed through Sella (S) and Nasion (N)

(2) Palatal Plane (PP) to Frankfort Horizontal (FH)—a plane formed through Porion (Po) and Orbitale (Or)

The following American Board of Orthodontics superimposition technique will be used:

(1) Craniofacial Composite—a registration on Sella (S) with the best fit of the anterior cranial base bony structures including planum sphenoidum, cribiform plate, greater wings of the sphenoid [3]. This technique will assess growth and treatment changes throughout the given timepoints T1, T2, and T3.

Reproducibility of all the measurements will determined statistically by taking double measurements on a set number of radiographs measured 24 hours apart. This study will either be submitted for publication or written as a thesis to complete Kevin Knutson's MS in orthodontics.

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PROJECT TITLE: "Extensions to the Embedded Xinu Network Emulator"
FACULTY NAME: Dennis Brylow, PhD
STUDENT NAME: Kyle Thurow

INTRODUCTION

Introduced last year at the forward thinking poster session, Embedded Xinu's [1] network emulator is a tool designed to aid software developers and educators in building robust network software. Similar to other network emulators like ns2 [2], the Xinu network emulator is unique in that it runs on embedded routers. While other emulators exist that run on routers such as [3], Xinu's is specifically designed with embedded platform constraints in mind while others were ported as an afterthought. By running network traffic through four different modules (drop, delay, duplicate, and reorder) developers can control the flow of packets to mimic unreliable real-world conditions. Through this, they are then able to test their own software in a controlled, replicable environment allowing more thorough bug detection. This year's work focuses on creating additional modules, enabling developers to test under a greater variety of network conditions.

SIGNIFICANCE

Further additions to the emulator will provide programmers a wider range of tests, resulting in even more robust software. For instance, a proposed module for throughput control allows developers to simulate conditions of low bandwidth connections such as those found in remote locations or developing countries. Developers can then ensure that their software will still work well for people in these locations. Likewise, by modeling real-world effects, we can increase debugging efficiency by taking setting intelligent default settings. Other features such as finer grained network interface control and a web interface will also be explored.

FORWARD THINKING/INNOVATION

This project will extend previous work by providing additional modules and controls for manipulating network traffic. One module receiving attention is a throughput rate control module using techniques described in [4]. With such a module, developers are able to control how much data can travel through the network emulator per unit time, commonly referred to as "bandwidth." Using real-world modeling techniques as in [4], we can further improve results by using realistic default settings. By using a defaults similar to those seen on the internet, developers have a good base case to test against. These new features are innovative because they merge desired emulator features with our embedded network emulator, resulting in cost savings, increased portability, and a greater number of configurable network interfaces.

STUDENT INVOLVEMENT

This project will be undertaken almost entirely by Kyle Thurow. Faculty roles include only oversight and guidance. Design decisions, implementation and direction will all be under student control. Only when an insurmountable problem arises or more experienced insight is needed will faculty be consulted. Specifically Kyle is responsible for designing, coding, testing, and debugging all aspects of the throughput rate control module and the real world modeling as well as exploring the possibility of a web interface and greater interface control.

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PROJECT TITLE: "Porting Embedded Xinu to an 8-bit Arduino Core"
FACULTY NAME: Dennis Brylow,
STUDENT NAME: Steven Gago

INTRODUCTION

Teaching of operating systems, compilers, computer networks, and embedded devices can be onerous due to lack of homogeneous and reliable teaching methods and equipment. In addition, computer labs to teach these classes can be costly. Subsequently, students struggle with difficult basic concepts and universities go without a cost-effective uniform mode of teaching. To counter these issues, we suggest porting Embedded Xinu, a simple yet graceful operating system, to the 8-bit Atmel(R) AVR processor. Embedded Xinu is being used at several universities to teach embedded systems [1], operating systems [2], and hardware systems [3]. The Xinu operating system provides students with fundamentals in key operating system components including process scheduling, interrupt handlers, and dynamic memory allocation. It is with these goals in mind that we have begun adapting Xinu for the AVR processor.

SIGNFICANCE

Xinu currently operates on a wide array of platforms including the DEC PDP-11, Motorola[(R)] 68000, Intel[(R)] x86, and MIPS IV architectures. Porting Xinu to a scaled-down alternative architecture is advantageous for a number of reasons. First, diversification of the hardware will make adoption of Embedded Xinu easier for colleges and universities that already employ AVR processors in other course work. Next, the 8-bit Arduino Mega from ATMEL[(R)] provides several unique and interesting challenges for us. The AVR is disparate from all other platforms that Xinu presently operates on. Core Xinu files such as the context switch, context records, memory layout, and interrupt handlers need to be redesigned. However, once Xinu is successfully ported to the Arduino Mega it will open the doors to a variety of ATMEL platforms. Consequently, porting to other 8-bit and even 16-bit endeavors will be less arduous.

FORWARD THINKING/INNOVATION

The design of Xinu for the AVR is innovative because unique architecture of the Arduino Mega. Additionally, this will provide colleges with a simple teaching solution for multiple courses such as compilers, operating systems, and embedded devices. As a result, this operating system will further advance education in complicated computer science courses.

STUDENT INVOLVEMENT

Steven Gago wll be designing Xinu for the AVR process with support from Dr. Dennis Brylow and Team Xinu. The process for writing Xinu for the Arduino Mega 1280 will be accomplished in five steps. (1) Cross-compile code for the platform. (2) Following a successful blinking LED program, core Xinu header files and libraries such as string.h, stdio.h, and stdlib.h will be added to the project which add a framework and some useful functions. Many of the functions will need to be redesigned as they will not operate correctly on an 8-bit platform. (3) A platform-specific context switch must be created. (4) Platform specific interrupt structure must be designed. Interrupts are handled by an interrupt table and the associated interrupt vectors are stored in program memory space. Interrupts are assigned a different priority levels with the lower memory addresses having a higher priority. (5) The Arduino Mega has 4 USARTs and basic I/O is presently handled on only one USART via a synchronous serial driver though it is planned to implement asynchronous serial driver.

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Forward Thinking Poster Abstract

PROJECT TITLE: Real-Time Multimedia on Embedded Xinu
FACULTY NAME: Dennis Brylow, PhD, Assistant Professor, MSCS
STUDENT NAME: Kyle Persohn, Graduate Research Assistant, MSCS & EECE

INTRODUCTION

Real-time multimedia has become ubiquitous in many embedded devices with the explosion of popular personal media devices. An increasing number of smartphones, iPads, and television set-top boxes are connecting to the Internet to stream content on-demand. Popular services like Netflix, Skype, YouTube, and Pandora stream audio and/or video with real-time multimedia technology to users in their living rooms and on the go. In many cases network bandwidth is limited and unpredictable, especially for wireless devices. Therefore it is crucial to have software capable of providing a robust transport in order to ensure quality of service (QoS) to the end-user.

SIGNIFICANCE

As technology evolves it is important that development and educational tools remain on the cutting edge. The Nexos laboratory [1] allows students to explore embedded systems with a highly hands-on approach. This project aims to integrate Voice-over-Internet Protocol (VoIP) technology [2] into project Nexos with popular streaming technology [3]. This contribution is two fold: we provide unique tools for students to learn the current state of the art in addition to a framework which will support the research and development of next generation streaming technology.

FORWARD THINKING/INNOVATION

Adding real-time multimedia support to Embedded Xinu will innovate the curriculum for classes at Marquette such as Embedded Systems and Networking & Internets. Students will be able to apply knowledge learned in the classroom to engaging laboratory experiments which demonstrate the tradeoffs between different streaming technologies. Furthermore, this project will assist researchers in the Systems Laboratory to analyze and develop new codecs (coding/decoding algorithm) for streaming media. Not only do we hope to innovate how students learn about current technology, but also how they can apply their knowledge to create streaming technology for the future.

STUDENT INVOLVEMENT

Students will be the primary contributors to this project and ultimately the primary benefactors as well. Kyle Persohn, Graduate Research Assistant for the Systems Laboratory, will take the lead roll on this project with supervision from Dr. Dennis Brylow. Mr. Persohn will continue to develop the hardware proposed in [2] so it is cost-effective for our our partner universities to adopt. In addition, he will integrate the Real-Time Transport Protocol (RTP) [3] into Embedded Xinu for educational and development use. In the future, we hope to use this work to develop a new profile for Internet telephony usage.

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1

PROJECT TITLE: Understanding and Measuring Functional Impairment in Latino Children with ADHD:
Development and Validation of the ADHD-FX Scale
FACULTY NAME: Alyson C. Gerdes, Assistant Professor, Psychology
STUDENT NAME: Lauren M. Haack, M.S, Doctoral Candidate, Psychology

INTRODUCTION

Measuring and understanding functional impairment in diverse children with ADHD is an extremely important area of research that is in its infancy in the field of clinical psychology. The functional impairments related to academic achievement, social competence, and familial relations experienced by children with ADHD lead to long-lasting and debilitating difficulties that adversely affect the individuals themselves, their families, and society[1]. In addition, limited available research suggests that ethnic minority children (particularly within the rapidly growing Latino population) are at as great or greater risk for developing ADHD[2], although they are much less likely to be identified by their parents as displaying problematic behavior and subsequently are less likely to receive proper assessment and treatment[3]. In order to provide the best possible assessment and treatment practices to Latino children with ADHD, clinical research needs to be expanded to include examination of functional impairment related to ADHD, which appears to be a more universally-shared construct than identification of DSM-IV symptoms.

SIGNIFICANCE

Unfortunately, there is a current lack of practical, efficient, and culturally-appropriate assessment measures examining functional impairment related to ADHD[4]. The creation of such a measure would not only improve assessment procedures for Latino children with ADHD, but also would guide culturally-appropriate treatment aimed at improving functional impairment experienced by children with ADHD and their families. Thus, the goal of the current study will be to develop and validate a measure of functional impairment related to ADHD (including three domains - academic achievement, social competence, and familial relations) that is specifically designed for use with the Latino population. This measure will have the potential to be used during comprehensive ADHD assessments to aid in diagnosis, case conceptualization, and treatment planning, as well as throughout and following treatment to evaluate statistically significant and clinically meaningful gains that have been made in important domains of functioning relevant to children with ADHD and their families. This is the first step toward providing mental health providers with the ability to conduct a culturally and linguistically-appropriate ADHD assessment with the rapidly growing, yet grossly underserved Latino population.

FORWARD THINKING/INNOVATION

Despite current multicultural guidelines calling for culturally-appropriate assessment and treatment practices for ethnic minority families[5], this is the first study of its kind attempting to *develop* an ADHD assessment measure specifically with Latino families in mind. Additionally, this project will provide the necessary foundation for future faculty and student research projects focused on developing a culturally-modified treatment for Latino children with ADHD. Dr. Gerdes and Ms. Haack plan to use this pilot data to support a NIH grant to compare standard ADHD treatment to a culturally-modified treatment.

STUDENT INVOLVEMENT

Ms. Haack will take the lead on this project in collaboration with Dr. Gerdes. Specifically, she will be responsible for obtaining IRB approval, overseeing undergraduate research assistants, participant recruitment, data collection, data entry/coding, and data analysis. The results of this project will serve as Ms. Haack's dissertation project and will result in several publications in an effort to disseminate the results. Ms. Haack currently is serving as the research coordinator for the Latino Family Project, which serves as a pilot to the current study (in progress).

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PROJECT TITLE:
Mechanical Characterization and Model Development of a Composite Humerus for Future Application in Osteogenesis Imperfecta (OI)

FACULTY NAME: Gerald F. Harris, PhD, PE, Professor, Biomedical Engineering, Director OREC
STUDENT NAME: Prateek Grover, MD; NIDRR ARRT Postdoctoral Fellow, Orthopaedic Surgery, Medical College of Wisconsin; Doctoral Candidate, Biomedical Engineering, Marquette University

INTRODUCTION

Finite element (FE) modeling of long bones has been used for clinical applications to evaluate mechanical parameters such as stress and strain, using experimentally derived inputs. Artificial composite bones (Sawbones Inc., Vashon, VA) offer biofidelic geometry for FE modeling. Compared with cadaveric bones, composites have very little interspecimen variability and do not require special tissue preservation. The current "fourth generation" composite used in this study are designed to better replicate cortical and cancellous long bone properties.

Osteogenesis Imperfecta or brittle bone disease is the most common heritable connective tissue disorder with a global prevalence of 1:10,000 [2]. This heterogeneous disorder primarily involves qualitative or quantitative Type I collagen defects, which result in bone fragility [1, 3]. Structural characteristics of this bony pathology can be modeled with the FE technique.

The goal of this study is to develop a long bone FE model. Specific aims include incorporation of the fourth generation composite Humerus (SH4/Model 3404); experimental evaluation of the SH4 diaphysis; and, simulation of experimental results for model validation. The validated FE model will be used in future work to investigate fracture risk in OI subjects using Lofstrand (Canadian) crutches.

SIGNIFICANCE

Composite long bones of the femur and tibia have been extensively characterized. However, beyond a description of composite rigidity, there is little data currently available on the adult humerus. FE models of the composite humerus are also lacking and not reported in current literature. Mechanical property data on the humerus would complement existing studies and add significantly to our knowledge base and future modeling potential. A standardized humerus model would also support development of patient specific fracture predictive tools. An immediate clinical application would be fracture prediction/prevention in OI. Quantitative model outputs on stress magnitude and distribution could be used for activity modification, clinical care and therapeutic rehabilitation.

FORWARD THINKING/INNOVATION

This study involves innovation at several levels. It aims to provide novel information on mechanical properties of a composite humerus. A new tool, a FE model of the standardized adult humerus will be available to researchers, and could be used to develop patient specific models. Potential expanded applications include osteoporosis, trauma, fracture fixation and arthroplasty. Correlation with functional outcomes tools could provide additional clinical insight. Overall contributions from the study include a more robust biomechanical tool, a standardized FE model, the capacity for patient specific models, and improved statistical insight.

STUDENT INVOLVEMENT

Dr. Prateek Grover, MD is conducting the project, with guidance from Dr. Harris. Dr. Grover has experimentally characterized mid-diaphysial strains, construct stiffness and rigidity of the SH4. He has also developed a protocol for CT scan geometric model analysis (MIMICS, Solidworks and ABAQUS). He has completed simulations with the FE model which incorporate SH4 geometry, material properties, boundary conditions and loads. Dr. Grover is now validating the FE model.

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PROJECT TITLE: "Methodology for studying fracture material behavior in osteogenesis imperfecta"
FACULTY NAMES: Carolyne Albert PhD, Postdoctoral Fellow, Orthopaedic Research and Rehabilitation Engineering Center (OREC); and Gerald Harris PhD, PE, Professor of Biomedical Engineering and Director of OREC
STUDENT NAME: John Jameson BS, PhD Candidate, Biomedical Engineering

INTRODUCTION

Osteogenesis imperfecta (OI) is a genetic disorder affecting the production and assembly of type I collagen and resulting in bone fragility. At the material level, higher than normal bone mineral density has been observed in OI[1,2]. At the structural level, histological studies have also noted lower cortical thickness and fewer/thinner trabeculae[2-4]. Current literature suggests that the impaired collagen network and abnormal mineralization affects the material properties of bone tissue. However, due to a lack of appropriate testing methods and a scarcity of bone specimens available for testing, there are limited studies of OI bone material properties in human subjects. Furthermore, it is not clear whether the increased risk of fracture in OI is attributed more to compromised material-level properties or to abnormal bone structure and altered loading patterns.

SIGNIFICANCE

Finite element (FE) models were developed recently to help assess fracture risk in children with OI[5]. These models have been useful in investigating the roles of factors such as muscle and joint loads on stress distribution in the bone during gait. Incorporation of accurate material properties would allow these models to be used for fracture risk assessment. Accordingly, the current study will focus on characterizing the material properties of bone in children with OI, with the aim of improving the fracture-risk prediction capability of current FE models.

FORWARD THINKING/INNOVATION

This study represents the first attempt at characterization of the material strength of human OI bone. A combination of mechanical tests (microstructural and nanoindentation) and imaging (micro-computed tomography, microradiography, and scanning electron microscopy) will be used to examine the distribution of local intrinsic properties and the fracture behavior of bone specimens obtained from children with OI. This study will provide a better understanding of the primary mechanisms behind the increased risk of fracture in pediatric OI patients. The results will also provide more accurate inputs for current finite element models, which will aid in the development of improved clinical interventions in children with OI.

STUDENT INVOLVEMENT

John Jameson will lead the imaging component of this study, which will be included as part of his dissertation. He will adapt imaging methods he has previously developed for analyzing murine OI bone. He will also assist in developing the mechanical test protocols, as well as participate as a co-author in the publishing of all results.

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PROJECT TITLE: "Novel Feature Extraction for Bilingual Speaker Verification"

FACULTY NAME: Dr. Michael T. Johnson, Associate Professor, Electrical and Computer Engineering

STUDENT NAME: Jianglin Wang, Electrical and Computer Engineering Doctoral Candidate

INTRODUCTION

The task of speaker identification and verification has received a great deal of attention from the research community in the past decade, and there have been substantial gains in accuracy as well as channel and background robustness [1][2]. However, automatic speaker recognition systems have mainly been explored in a single language or mono-lingual environment. The performance degrades for cross-lingual tasks where there are multiple languages, both training and testing, as opposed to monolingual tasks, since the phonetic features used in monolingual tasks are less useful in a cross-lingual or multi-lingual environment. The fundamental mechanism of state-of-the-art systems has remained phonetic rather than physiological in nature, and little progress has been made toward identifying individually unique speech characteristics that are independent of phonetic content [3][4]. One approach used to deal with this problem is to find additional non-phonetic features to reinforce system robustness in language-mismatched conditions.

SIGNIFICANCE

The objective of this proposal is to create novel feature extraction methods to capture speaker-specific features from the speech signal and linear predictive (LP) residual signal, to be used for bilingual speaker recognition. This project has a significant application such as forensic speaker recognition, which needs to be robust across language. Examples of such features might include those more related to source excitation rather than vocal tract.

FORWARD THINKING/INNOVATION

This research is innovative because it is targeted at the development of a novel speaker-specific feature to solve the problem of human speaker recognition in language-mismatched conditions. The investigated speaker-specific features provide an alternative approach to language-mismatched with the potential to substantially reinforce the robustness of speaker recognition.

STUDENT INVOLVEMENT

Under the supervision of Dr. Michael T. Johnson, a Ph.D. candidate Jianglin Wang, will take the lead in this project. Jianglin Wang will be responsible for feature extraction and experimental verification of the proposed project.

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PROJECT TITLE: "Objective evaluation of speech intelligibility"
FACULTY NAMES: Michael T. Johnson, PhD, PE, Associate Professor, EECE
                         Richard J. Povinelli, PhD, PE, Associate Professor, EECE
STUDENT NAME: An Ji, Doctoral Student, EECE

INTRODUCTION

The digital manipulation of speech has become ubiquitous. Cell phone systems, voice over internet, and the vast majority of electronic voice communication now incorporate substantial speech compression methods to minimize bandwidth and maximize system capacity. One of the most important components of selecting computer-based speech algorithms is the evaluation of the perceptual distortion, in terms of both signal quality and intelligibility, to the speech. However, evaluation of perceptual distortion, and in particular evaluation of intelligibility, is nearly impossible to do without carefully designed human studies, which given the typical level of configurability and number of parameter variations possible imposes a huge burden on algorithm developers. The proposed research focuses on a novel approach to predicting speech intelligibility, the Objective Evaluation of Speech Intelligibility (OESI). The aim is to develop an objective evaluation of speech intelligibility that correlates with subjective intelligibility listening tests at a greater than 0.95 level of correlation, enabling the use of the OESI as a replacement for human studies.

SIGNIFICANCE

The primary goal of speech systems is clear communication, in many ways speech quality is a much less important metric than speech intelligibility, which measures the degree to which the received signal is accurately understood by the listener. Despite the tremendous progress in developing objective methods for quality assessment, there has not been similar progress in developing objective methods for intelligibility assessment, and there is a great need for work in this area. While quality and intelligibility are correlated, they are not synonymous. In fact, it can be argued that the use of quality rather than intelligibility as a primary metric has led to misguided research directions, with incremental improvements to quality coming at the expense of intelligibility. In the area of speech enhancement, it has been recently shown [1] that while a great many different approaches give statistically significant improvements in perceived signal quality, none lead to statistically significant improvements in intelligibility in more than one noise environment, with the summary being that current enhancement methods simply don't improve signal intelligibility in a substantial way. Successful development of this approach will contribute significant advances in speech intelligibility models. The work proposed here addresses this need through the creation of a novel phoneme-specific intelligibility model coupled with an information theoretic integrative model at the word level.

INNOVATION

The key innovation proposed here is the use phoneme-specific intelligibility models to create better understanding of and objective assessment tools for the evaluation of speech intelligibility. The scientific merit lies not only in its contribution to our fundamental understanding of the acoustic correlates of intelligibility through a comprehensive set of perceptual studies, but also in development of parametric assessment models based on those studies. Core research questions include identifying the phoneme specific correlates of intelligibility and using those to create predictive models for phoneme-level and word-level intelligibility. The outcomes of this study will include a practical test corpus and assessment tools with which developers and researchers can easily evaluate the impact of environmental noise and digital processing on speech intelligibility, opening the door for creation of new approaches to coding and enhancement algorithms more focused on the fundamental communicative goal of maintaining intelligibility.

STUDENT INVOLVEMENT

EECE PhD student An Ji will take responsibility for this project with the support of Dr. Johnson and Dr. Povinelli. An has done some work in phoneme articulator analysis and plans to study articulatory modeling for her dissertation. This project is a good fit with her dissertation topic and will help her develop a more accurate articulator model from an intelligibility aspect.

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PROJECT TITLE: Measuring Domain Wall Manipulation with Magnetic Force Microscopy
FACULTY NAME: Andrew Kunz, Assistant Professor Physics
STUDENT NAMES: Daniel Olson, Rebecca McAuliffe, Undergraduate Physics Majors

INTRODUCTION

In long, thin magnetic nanowires the magnetic moments lie in the plane of the wire and are oriented along the long axis creating a magnetic domain. The wire geometry ensures that each additional magnetic domain will be oppositely oriented with a transition region between the domains – called a domain wall. These domain walls can carry information and can be moved rapidly leading to many proposed domain wall device applications in data storage and sensing[1-2]. Knowledge of the physical mechanisms for injecting, moving, and controlling domain walls is critical for creating working devices. Recent simulations have made many predictions about techniques allowing for fast, reliable control of the domain walls in nanowires[3-5]. Our collaboration with the University of Minnesota is now in a position to explore our predictions experimentally.

SIGNIFICANCE

In addition to the fast speed that nanowire devices are predicted to operate; they may also overcome spatial constraints due to the fact that a wire can be bent. Unfortunately in the wire geometry a domain wall is energetically unfavorable, meaning that it must be externally injected with magnetic fields. In the conventional method, the injection field is large which unfortunately leads to slow domain wall motion. Our recent work has predicted a technique to inject the domain walls with small magnetic fields. This technique allows for the fastest domain wall motion, injection of multiple domain walls into the wire, and protects the domain wall magnetic structure which is critical for subsequent control after injection. This project will be the first experimental study of the technique the results of which will impact the device design and provide opportunities for experimentally studying a wide range of domain wall dynamic processes. This work is supported by a new three year grant from the NSF. (DMR-1006947)

FORWARD THINKING/INNOVATION

The proposed device structure is already innovative in that it provides a route for fast domain wall injection with the weakest magnetic fields. Additionally it provides a route for injecting multiple domain walls for the first time. This behavior will allow for experimental studies of the interactions of the domain walls, which is necessary for designing good devices. This is the only known technique which can study a variety of interactions allowing us to stay at the forefront of the field. Additionally a new domain wall structure can be created which has been predicted to be stationary. We recently proposed a technique for quickly moving the wall which could impact applications for biosensors and drug delivery systems[5]. A set of magnetic samples has been made which will allow for investigation of this prediction.

STUDENT PARTICIPATION

Rebecca McAuliffe and Daniel Olson, undergraduate physics majors, will be carrying out the simulation and experimental study of the magnetization dynamics. Travel to the Magnetic Microscopy Center at the University of Minnesota will be required so that the students can learn how to operate a magnetic force microscope which will be used to do the experimental analysis. Approximately two weeks in the summer of 2011 will be spent in Minneapolis to complete the experimental study the rest will be completed here.

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PROJECT TITLE: Application of Extracorporeal Shock Wave to Modulate Alveolar Bone Remodeling
FACULTY NAME: Dawei Liu, DDS MS PhD, Assistant Professor, Dentistry
STUDENT NAME: Josh Barta DDS (1st year orthodontic resident)

INTRODUCTION Today over half of the population seeks orthodontic treatment (dental braces) to straighten up their teeth and improve dento-facial appearance[1]. However, orthodontic treatment is facing two major challenges - longer treatment time (2-3 years on average) and iatrogenic root resorption. Therefore how to reduce the treatment time and root resorption becomes a very important issue to orthodontic clinicians and the focus of researchers. Orthodontic tooth movement (OTM) is a mechanically induced bone modeling process wherein bone resorbed on the pressure side of periodontal ligament (PDL) and deposited on the tension side. Decortication (surgically drilling and/or cutting alveolar bone between dental roots) has been used to move teeth faster through wound healing, which however is a surgical procedure and not well accepted by patients. Therefore if a non-surgical approach can be used to modulate bone modeling to help move teeth faster, it will be a big benefit to the patients. Extracorporeal shock wave (ESW) is low frequency high-pressure wave, often used to destroy ectopic bone formation in body like kidney stone. Recently ESW has been shown to be able to treat musculoskeletal disorders such as ligament desmitis and osteoarthritis[2]. In a recent study[3], ESW has been shown to be able to increase bone microcracking in equine limb bone in vivo[3], however no insights into mechanism has been gained. Based on these, we hypothesize that ESW can be applied to increase bone turnover rate by generating microcracks in the alveolar bone to move teeth faster. To test this hypothesis, we are going to establish an *ex vivo* organ culture model by harvesting calvaria bone from the 3-5 days of neonatal mice. The collected calvaria will be cultured in 10% FBS supplemented DEME and subjected to three doses of ESW as low ($0.1 mJ/mm^2$, 4 Hz, 2000 shocks), medium ($0.25 J/mm^2$, 4 Hz, 2000 shocks), and high ($0.5 mJ/mm^2$, 3 Hz, 2000 shocks) doses once. After ESW stimulation, the bone organs will be further cultured for 1 week, to be examined by histological and histomorphometric analysis. Student T test will be used to compare parameters between ESW-timulated and non-ESW stimulated groups, with p value set at 0.05.

SIGNIFICANCE Effect of ESW on alveolar bone modeling has not been explored, which prevents us from applying ESW to increase bone remodeling during OTM. Completion of this project will not only add new knowledge to the understanding of how ESW modulates bone modeling, but also lead to the generation of a prototype of ESW appliance to apply to orthodontic patient. In addition, the preliminary data to be obtained will allow us to apply for extramural funding from NIH.

FORWARD THINKING/INNOVATION To the best of our knowledge, we are the first to explore the effect of ESW on bone remodeling using bone organ culture system, which will uncover the cellular and molecular mechanism of ESW's effect on bone tissues, and provide us with possible strategies to enhance bone remodeling in turn to move teeth faster during orthodontic tooth movement.

STUDENT INVOLVEMENT Josh Barta (1st year orthodontic resident) will participate in this project. He will completely be involved in designing and implementing experiments, analyzing data and writing research paper.

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PROJECT TITLE: Effect of Extracorporeal Shock Wave on Periodontal Ligament Cells in Vitro

FACULTY NAME: Dawei Liu, DDS MS PhD, Assistant Professor, Dentistry

STUDENT NAME: Tyriina O'Neil BS (1st year BME MS student)

INTRODUCTION In clinical orthodontics, two perplexing problems - longer treatment time (2-3 years on average) and its associated iatrogenic root resorption have never been solved. Therefore, how to reduce the treatment time and root resorption is becoming a significantly important task to orthodontists and basic scientists. Orthodontic tooth movement (OTM) is a mechanically-induced modeling of periodontium (alveolar bone, periodontal ligament - PDL, cementum) wherein bone resorbed on the pressure side and deposited on the tension side of PDL. PDL cells are playing critical roles in modulating the process of OTM[1]. Previous studies show that when mechanically activated, the PDL cells produce and release various bioactive molecules such as ATP, PGE_2, NO et al. to be actively participating and regulating the bone formation and resorption in the process of OTM. Although several possible surgical (e.g. decortication) and non-surgical (e.g. ultrasound) means have been explored to help move teeth faster, their cellular and molecular mechanisms are NOT known. Extracorporeal shock wave (ESW) is low frequency high-pressure wave, conventionally used to disintegrate ectopic bone formation like kidney stone[2]. Recently, ESW has been shown to be able to increase proliferation and protein production in osteoblasts, tendon cells and chondrocytes[3]. In parallel to another project in which we were studying the effect of ESW on bone organ, in this project we are planning to investigate the effect of ESW on periodontal cells in culture in an attempt to reveal the cellular and molecular mechanisms of ESW. Based on current literature, our hypothesis is that ESW under certain energy level will stimulate PDL cells to produce bioactive molecules which will in turn regulate bone remodeling during OTM. To test this hypothesis, we are going to culture PDL cells from mice and subject them to three doses of ESW ($0.1mJ/mm^2$, 4 Hz, 2000 shocks; $0.25J/mm^2$, 4 Hz, 2000 shocks; $0.5mJ/mm^2$, 3 Hz, 2000 shocks), respectively. Immediately after stimulation, medium will be collected to assay ATP and PGE_2 releases by ELISA. After further cultured for 6 hours, the cells will be harvested to examine gene expressions and protein productions of three key regulators of bone remodeling i.e. osteopontin (OPN), sclerostin (SOST) and receptor activator for nuclear factor κ B ligand (RANKL) by western Blot. Statistically, ANOVA will be used to compare each parameter between ESW-stimulated and non-ESW stimulated groups (p value set at 0.05).

SIGNIFICANCE Effect of ESW on periodontal ligament cells has never been investigated, which prevents us from applying ESW to help move teeth faster in orthodontics. Completion of this project will not only add new knowledge to our understanding of how ESW influences periodontal ligament cells, but also lead to a translation of the basic findings to the logical next step of research – animal experiment. In addition, the preliminary data to be obtained will allow us to apply for extramural funding from NIH.

FORWARD THINKING/INNOVATION To the best of our knowledge, we are the first to explore the effect of ESW on periodontal ligament cells, which will uncover the cellular and molecular mechanism of ESW's effect and provide us with possible strategies to enhance orthodontic tooth movement.

STUDENT INVOLVEMENT Tyriina O'Neil (1st year BME MS student) will participate in this project. She will completely be involved in designing and implementing experiments, analyzing data and writing research paper.

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PROJECT TITLE: "Marginal Ridge Thickness (MRT) of Maxillary Incisors in Orthodontic Patients"
FACULTY NAME: Dawei Liu, DDS, MS, PhD
STUDENT NAME: Mark Foster DDS, Orthodontic Resident

INTRODUCTION
When diagnosing and treatment planning orthodontic cases, space problem (both intra-arch and inter-arch) is the key factor to be considered in order to set up a normal occlusion with proper overbite and overjet. It has been generally accepted that the Bolton index is useful for figuring out the mesio-distal (M-D) discrepancy between the upper and lower dental arches.

SIGNIFICANCE
There is no index to judge the labio-palatal (or bucco-lingual) marginal thickness discrepancy which is hypothetically associated with the Bolton index. This study is to be conducted to answer the following questions: 1) Does labio-palatal (or bucco-lingual) marginal thickness index differ between males and females? 2) Does labio-palatal (or bucco-lingual) marginal thickness index differ between Caucasian and non-Caucasian patients? 3) How does the labio-palatal (or bucco-lingual) marginal thickness index associate with the Bolton index in determining how to set up ideal overbite and overjet for orthodontic patients?

FORWARD THINKING/INNOVATION
This study is innovative because it recognizes the challenges that crowding introduces to finishing orthodontic treatment. To our knowledge there has not been a study conducted that evaluated the MRT of anterior teeth.

STUDENT INVOLVEMENT
Mark Foster DDS will take the lead on this project with the support of and collaboration with Dr. Liu. Dr. Foster will screen upper and lower casts until 120 upper and lower casts of patients that meet the inclusion criteria are collected, he will then assign a number to each set of casts to blind him from the patients' personal information (e.g. name and chart#). However, under blindness the patients' age, gender and race will be collected in an Excel spreadsheet. For each of these 120 casts, a digital caliber with a resolution of 1/100mm will be used to measure the mesio-distal width of the upper and lower tooth width from 1st molar to 1st molar, from which the Bolton Index will be calculated. The marginal thickness of the upper and lower incisors will be calibrated in the following method:

   1) Using the long axis of the clinical crown as reference, mark the incisal 1/3 line on the mesial and distal margins (both facial and palatal/lingual sides) for all the upper and lower central and lateral incisors (as this is the level a normal OB and OJ need to be set at.

   2) Use the digital caliber to measure the mesial and distal marginal thickness of the upper and lower central and lateral incisors, perpendicular to the long axis of the crown.

   3) Export all the data into Excel spreadsheet. Statistical analysis (ANOVA) will be performed to determine if there is a difference in the marginal ridge thickness between males and females; and between Caucasian and non-Caucasian. As well, the correlation between labio-palatal (or bucco-lingua) marginal thickness index and Bolton index will be sought.

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PROJECT TITLE: "Role of mechanical stress in LPS-induced damage of periodontal cells in vitro"
FACULTY NAME: Dawei Liu, DDS MS PhD, Assistant Professor, Dentistry
STUDENT NAME: Yaroslav Yarmolyuk, DDS, Orthodontic resident 1st year

INTRODUCTION Today more and more adults seek orthodontic treatment (dental braces) to straighten up their teeth and improve dento-facial appearance (Proffit, 2007). However, different from children, adult patients are prone to periodontitis – a destructive disease damaging periodontal supportive tissues leading to loosened teeth (8-30% of adult population - Loe et al, 1986; Papapanou et al, 1989). Orthodontically, moving teeth with destructed periodontal tissues is very risky not only because the unhealthy periodontal tissues but also because if used inattentively the mechanical force could easily worsen the damaged periodontal status. With today's orthodontic techniques, periodontally compromised teeth can be reasonably managed, however the indications and guidelines haven not been fully established, mainly due to the lack of scientific evidence, for instance, the relationship between bacterial invasion and mechanical force in the periodontal tissues. By nature, periodontal disease is bacteria caused breakdown of periodontal tissues, and orthodontic treatment is mechanical force induced bone modeling and remodeling of periodontal tissues. Having the periodontal tissues in common, therefore the relationship between periodontitis and orthodontics at cellular level is the relationship between bacteria and its toxin and mechanical force in situ. Lipopolysaccharides (LPS) - a major product of bacteria has been shown to play a key role in tissue destruction of periodontitis (2-3). When cultured with cells, LPS caused apoptosis and cell death (2). Interestingly, mechanical force (fluid shear stress) has been shown to be able to survive the apoptotic cells in vitro (4). These findings trigger our mind to put forward a hypothesis that mechanical force may be able to survive the LPS-damaged periodontal cells. To testify this hypothesis, we are going to establish a cell damage model by treating the periodontal cells with LPS. Based on it, we will apply mechanical force (fluid shear stress) to see how the damaged cells be survived and explore possible mechanisms.

SIGNIFICANCE Interaction between bacterial damage and mechanical force on periodontal cells has not been known, which prevent us from gaining insight into the mechanism of mechanically moving periodontally compromised teeth in adults. Completion of this project will not only add new knowledge to the understanding of the interaction between mechanical force and bacterial toxin in the periodontal tissues, but also lead to evidence-based clinical strategy of treating periodontally compromised teeth in adults. In addition, the preliminary data to be obtained will allow us to apply for an extramural funding from NIH.

FORWARD THINKING/INNOVATION To the best of our knowledge, we are the first to explore the effect of mechanical stress on LPS-induced damage of periodontal cells, which will uncover the cellular mechanism of the interaction between bacterial damage and orthodontic force, and provide us with possible strategies to treat periodontally compromised teeth in adults.

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

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PROJECT TITLE: "Effects of rapid maxillary expansion on upper airway: a 3D cephalometric analysis"
FACULTY NAME: Dawei Liu, DDS MS PhD, Assistant Professor; Jose Bosio, DDS MS, Assistant Professor, Dentistry
STUDENT NAME: Yoon Chang, DDS, Orthodontic resident 2nd year

INTRODUCTION Rapid maxillary expansion (RME) is a commonly used orthodontic therapy to treat constricted maxillary arch and posterior cross bite, to expand the arch perimeter and alleviate dental crowding and to treat other functional problems[1]. Clinical studies evaluating the effects of RME and airway changes demonstrated that nasal airway resistance was reduced[2] and intranasal capacity improved[3,4]. In a follow up study, children diagnosed with obstructive sleep apnea who had RME were found to have a decreased apnea-hypoapnea index with a mean maxilla cross sectional expansion approaching 4.5 mm. Because the maxillary bones form the floor of the nasal cavity's anatomic structure, the midpalatal disjunction has been postulated to affect both the anatomy and the physiology of the nasal cavity decreasing nasal airway resistance and improving airflow[5]. RME has been even proposed as a treatment modality for obstructive sleep apnea based on the hypothesis that airway volume increases after maxillary expansion secondarily to tongue's repositioning more anteriorly in the oral cavity[2]. Unfortunately, studies on RME have traditionally consisted of analyzing the post-treatment effects of RME with dental casts, 2-dimensional cephalometric radiographs and human skull models[1,5,6]. Nevertheless with the advent of cone beam computerized tomography (CBCT) and the acquisition of 3-dimensional radiographic images with lower radiation exposure than medical CT, evaluation of the airway can be achieved accurately.

SIGNIFICANCE Our first aim of this study is to appraise the validity of using 3-D CBCT images to diagnose the airway dimension as the oropharyngeal cavity is surrounded by soft tissue at constant movement and susceptible to breathing, tongue posture and other unplanned movements. Secondly, we are planning to assess prospectively the effect of RME over the upper airway dimensions through the analysis of pre- and post-treatment 3-D CBCT images in children between 9 and 16 years of age undergoing comprehensive orthodontic treatment. The null hypothesis is that there is no difference in the mean changes in volumetric oropharyngeal airway within the same individual between pre and post RME.

FORWARD THINKING/INNOVATION To the best of our knowledge, we are the first to explore the effects of RME on the upper airway in a prospective manner. To do so, we took pre- RME CBCT scan and compared them to post retention (100 days after) CBCT scan within the same patient. With the use of Dolphin 3D software (version 11.0, California), segmentation of airway according to the radiographic density is possible, as well as the measurement of its total volume, minimal cross sectional area and the amount of expansion that each patient experiences.

STUDENT INVOLVEMENT Yoon Chang (2nd year resident in orthodontics) will participate in this project which will become his thesis leading to Master's degree. He will completely be involved in designing and implementing experiments, analyzing data and writing research paper.

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PROJECT TITLE: MRI Safe Pedaling Device for Examining Human Brain Activity
during Unilateral Pedaling after Stroke

FACULTY NAME: Dr. Sheila Schindler-Ivens

STUDENT NAME: Brett Arand

INTRODUCTION

Our laboratory has developed a method to examine human brain activity during locomotion[1]. This technique utilizes functional magnetic resonance imaging (fMRI) and a custom designed MR-safe pedaling apparatus. Pedaling was chosen as a model of locomotion because, unlike walking, pedaling can be performed while lying supine on an MRI scanner bed. While pedaling is not identical to walking, it is similar because both movements involve repetitive, reciprocal, flexion and extension movements of both legs. Using this method, we have shown that physiologically probable brain activation patterns can be obtained during pedaling using fMRI[1].

We are now using this technique to examine brain activity in people post-stroke to understand how the brain adapts after injury to restore locomotion. Individuals with stroke pedal bilaterally in a conventional manner whereby the legs move 180° out-of-phase. The right leg extends while the left leg flexes and vice versa. This technique has allowed us to observe inappropriate pedaling-related brain activity in people with stroke (unpublished observation). However, because both legs are moving, it is unclear whether the observed brain activation is due to **remapping,** whereby the function of damaged tissue is "taken over" by undamaged tissue, or due to **compensation** in which the non-paretic limb performs a larger portion of work. To help distinguish between these possibilities, a study of unilateral pedaling is required. **The purpose of this project is to design and fabricate an MR-compatible unilateral pedaling device and use this device to examine human brain activation during unilateral pedaling.** The device must simulate the contribution of the second leg to ensure that the pedaling leg experiences the same mechanical load as during conventional pedaling.

SIGNIFICANCE

Stroke is a leading cause of serious, long term disability in the United States that affects 6.5 million Americans[3]. Impaired walking ability post-stroke is a major obstacle to quality of life[2-5]. Currently, the mechanisms underlying recovery are poorly understood. Using functional imaging, we can increase our understanding of the locomotor-related changes in brain function after a stroke. This knowledge can then be used to predict treatment effectiveness and to identify physiological markers of recovery[4], with the ultimate goal of improving treatment techniques for the large number of people who have suffered a stroke.

FORWARD THINKING/INNOVATION

To our knowledge, an MR-safe, unilateral pedaling device does not currently exist; therefore this will be the first device of its kind. The device will allow the two pedals to be coupled for conventional pedaling or decoupled for unilateral motion. It will also utilize a simple, yet novel, mechanical system to ensure that the pedaling leg experiences the same mechanical load as during conventional pedaling. As the user pedals during the downstroke, an elastic band will be stretched by an eccentric pulley to store the energy which will be applied back through the system to assist during the upstroke.

STUDENT INVOLVEMENT

This research project will be performed by Brett Arand, who is a PhD student in Biomedical Engineering, working under the supervision of Dr. Sheila Schindler-Ivens. The unilateral pedaling device described here was designed and will be fabricated by Brett. The student will also use the device to examine brain activity during unilateral pedaling in people post-stroke in order to shed light on the mechanisms underlying recovery of locomotion post-stroke.

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Design of Stochastically Resilient Observers for Nonlinear Discrete-Time Systems.

Faculty Names

Edwin Yaz, Susan Schneider, and Chung Seop Jeong (Dept. of Electrical and Computer Engineering)

Student Names

Fan Feng (Dept. of Electrical and Computer Engineering)

Introduction

In control system design, observers are used to reconstruct the internal state variables of dynamic systems which cannot directly be measured by available sensors. This work addresses the important problem of stochastic resilience or non-fragility of a discrete-time Luenberger observer for a class of nonlinear systems involving incrementally conic nonlinearities with finite energy disturbances. Resilience is the maintenance of convergence and/or performance when the observer gain is erroneously implemented due possibly to computational errors i.e. round off errors in computing the observer gain or changes in the observer parameters during operation. The error in the observer gain is modeled in a stochastic way and a common linear matrix inequality framework is presented to address the stochastically resilient observer design problem for a variety of performance criteria.

Significance

In this study, we aim to improve work for the stochastic resilience of an observer. Uncertainties are allowed in the observer gain. Based on this perturbed model, Linear Matrix Inequality (LMI) techniques are introduced to find the gain of the observer that will tolerate time varying uncertain random perturbations.

Forward Thinking / Innovation

During our previous research in improving the stochastic resilience of observers for a class of continuous-time nonlinear systems, a suggestion was made to work on the discrete-time counterpart. So, this work can be seen as a natural follow up of the previous stochastically resilient observer for a class of continuous-time nonlinear systems.

Student Involvement

The student will derive the design formulas and use the LMI toolbox of Matlab package to perform the simulations. These simulations will be performed for different kinds of perturbation directions and various performance criteria.

Reference

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PROJECT TITLE: "Detection of Metal Ion Contaminants in Waste Water Using Guided SH-SAW Sensors"
FACULTY NAME: Susan Schneider, PhD, Associate Professor of Electrical and Computer Engineering and Director of Undergraduate Studies
Fabien Josse, PhD, Professor of Electrical and Computer Engineering and Director of Microsensors Research Laboratory
STUDENT NAME: Tian Newman, Dept. of Electrical and Computer Engineering M.S. degree Student

INTRODUCTION

The presence of metal ions in the environment continues to be of great concern to the scientific community. Most of these metals enter surface and ground water as a result of industrial processes. In order to ensure the quality and safety of water supply, early detection of contaminants including metal ions is critical. Currently, samples must be collected and transported to laboratories for analysis. As a result, analyses are delayed and vital information is lost. Furthermore, because some metal ions are used in developing nuclear weapons, early monitoring of processing waste will allow first responders to take appropriate steps to mitigate dangers. Consequently, there is a need for developing tools that can be used for the real-time detection and monitoring of harmful levels of metal ions in ground and waste water contaminants.

SIGNIFICANCE

Biosensors have been developed for the detection of metal ions. These sensors typically perform detection using fluorescence properties of metal upon their attachment to a bioreceptor. Some of the major drawbacks of these sensors include irreversibility, slow response, low selectivity, and low sensitivity[2]. The objective of this project is to develop a chemical sensor that will allow for metal ions to be identified and quantified with high sensitivity and selectivity. Among the class of acoustic wave devices that can operate efficiently in liquid, the polymer-coated SH-SAW device has been shown to be a very sensitive sensor platform. This sensor platform will be used in this investigation. The various heavy metal ions that will be investigated are aluminum, cadmium, cezium, chromium, and copper. In order to detect these specific metal ions, a sensing polymer needs to be chosen and characterized.

FORWARD THINKING/ INNOVATION

A chemical sensor that can successfully detect and measure the concentration of metal ion contamination will not only be helpful to the environment but provide a safer world to live in. Dr. Fabien Josse will use the knowledge gained from this research project to better understand chemical sensors and its applications. Allen Chaparadza is planning on extending this research to other metal ions other than the ones specified previously.

STUDENT INVOLVEMENT

Tian Newman will take the lead on the project with the support of and collaboration with Dr. Susan Schneider and Dr. Fabien Josse. Tian Newman will characterize the polymer (electrical and mechanical) and explore its sensing applications. Dr. Susan Schneider and Dr. Fabien Josse will provide direction and guidance for detection and analysis of metal ions in aqueous solutions. Arnold Mensah-Brown, a Ph.D. candidate, will train and assist Tian Newman in all procedures for experimentation. Allen Chaparadza, a Post Doctoral Research Associate for the Chemistry Department, will assist in selecting and/or designing an appropriate polymer for detection of metal ions in aqueous solutions.

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PROJECT TITLE
Extensions of Discrete-Time Optimal Disturbance Accommodation Control

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

STUDENT NAME
Katrina Barhouse, M.S. Student, EECE Department

INTRODUCTION
This research will investigate and analyze the stability and performance of a discrete-time disturbance accommodation control design. Disturbance accommodation control is a control scheme which minimizes the effects of a disturbance with a known waveform but unknown arrival time, duration and magnitude. This work will extend the research on deadbeat discrete-time disturbance accommodation control [1].

SIGNIFICANCE
Although the discrete-time minimum-time disturbance accommodation controller provides a fast response, it requires a high control input magnitude which could lead to an impractical and/or costly implementation [2]. A high input control magnitude would require unreasonable energy and power requirements for the system. Instead, a nearly minimum time optimal disturbance accommodation controller will be developed resulting in a lower control input magnitude while still achieving a fast response time.

FORWARD THINKING/INNOVATION
The discrete-time disturbance accommodation controller will be developed by introducing a constraint for the minimization of the control input [3]. The addition of this constraint will provide lower energy and power requirements creating a system designed for practical implementation. Performance analysis of the controller for different design parameters will result in the development of an optimal and stabilizing solution.

STUDENT INVOLVEMENT
For this research, the student will conduct the project as mentioned above. The student will work with the faculty to implement the design of the discrete-time disturbance accommodation controller on various benchmark systems to demonstrate stability and optimal performance.

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PROJECT TITLE
Finite-Time Stabilization of a Class of Nonlinear Systems

FACULTY NAMES
Edwin E. Yaz, PhD, Department of Electrical and Computer Engineering
Susan Schneider, PhD, Department of Electrical and Computer Engineering

STUDENT NAME
Mohammad N. ElBsat, PhD Student, Department of Electrical and Computer Engineering

INTRODUCTION
To the control community, the stability problem of a system is generally related to Lyapunov Asymptotic Stability, LAS, over an infinite-time interval. An alternative type of stability, known as finite-time stability or short-time stability, was introduced in [1], [2]. A system is said to be Finite-Time Stable, FTS, if the states of the system do not exceed a prescribed bound over a fixed-time interval. Since then, several extensions have been developed and implemented in the field of finite-time stability [3]. However, most of the work is applicable to only linear systems. In this work, finite-time stabilization of a class of nonlinear systems is to be considered.

SIGNIFICANCE
Lypaunov asymptotic stability conveys the state of the system asymptotically over an infinite-time interval. Finite-time stability, on the other hand, can show whether the transient states of the system will exceed a prescribed bound over a fixed-time interval or not. This is especially of interest in the case of systems with uncertain dynamics and additive disturbances.

FORWARD THINKING/INNOVATION
Finite-time stabilization via state-feedback of a class of discrete-time nonlinear systems with conic type nonlinearities, additive disturbances, and bounded control gain perturbations is to be considered. The aim of the work is to derive sufficient conditions for the existence of a robust and resilient finite-time linear state-feedback controller for this class of systems. A solution for the controller gain can be obtained by transforming the conditions developed into a linear matrix inequality feasibility problem. Thus, given a nonlinear system with uncertain dynamics and applying a linear state-feedback controller, it is possible to check whether the closed-loop system is finite-time stable over a fixed-time interval. Consequently, we are able to guarantee that the state of the system be confined within a prescribed bound despite any exogenous disturbances or control gain perturbations. Numerical simulations are to be executed in order to back up the developed theoretical results.

STUDENT INVOLVEMENT
Mohammad N. ElBsat, PhD student, will be working on developing the sufficient conditions for the different extensions of the considered work and running simulations that back up the theory developed.

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Project Title: Nonlinear Accommodation Analysis of the Discrete-time Neoclassical Controller
Faculty Names: Edwin Yaz, Ph.D., Department of Electrical and Computer Engineering (EECE)
Susan Schneider, Ph.D., EECE Department
Student Name: W. Alexander Baker Jr., Ph.D. Student, EECE Department

Introduction

Neoclassical control combines the use of classical control concepts of transfer functions, integrators, and pre-compensators with modern control's state space modeling and state feedback control. By combining these classical and modern control techniques, a more efficient control design procedure has been developed which allows for quick design and accurate results. Neoclassical control has been successfully applied to continuous-time and discrete-time, linear, time invariant, single input single output systems [1, 2]. To test the robustness of the controller, the discrete-time neoclassical controller will be applied to three nonlinear test systems to see how much nonlinearity the controller can accommodate.

Significance

Neoclassical control has demonstrated the ability to remove the trial and error of classical control, eliminate steady state error, and precisely match the output of the system to a desired standard transfer function for linear systems. However, almost all real world systems are nonlinear. The neoclassical controller will be tested on several nonlinear test systems in order to quantitatively analyze the limit to which the controller will no longer be able to exercise control over the nonlinear system [3].

Forward Thinking/Innovation

The neoclassical controller design procedure is already designed for linear systems. The use of neoclassical control in the real world will be a step closer after the robustness study of the controller's ability to accommodate the nonlinearity of the system. The information gained from the robustness study has the potential to pave the way towards a neoclassical controller which is specifically designed for nonlinear systems.

Student Involvement

Mr. Baker will carry out the work in collaboration with the faculty. The nonlinear system will be simulated with and without the neoclassical controller. Mr. Baker will analytically investigate the robustness of the controller and use the simulations to numerically verify the extent of the neoclassical controller's ability to accommodate nonlinearity.

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Project Title: The effects of physical practice on the performance of novice kickboxing subjects.

Faculty name: Andrew Starsky MPT, PhD, Clinical Assistant Professor, Physical Therapy

Student Name: Jordan French, Undergraduate student, Department of Exercise Science

INTRODUCTION: Studies have shown that perceptual abilities as well as efficient motor recruitment are essential to successful sports performance[1,2]. Martial arts, particularly kickboxing, are a good example of a sport that incorporates both power and speed. Effective ways of gauging speed and power in sports such as martial arts are through reaction time, movement time, and force output. Physical practice of martial arts kicks will likely improve the parameters of those kicks, but may also carry over into other kicks that were not practiced[3]. This pilot study was carried out to examine the carryover of physical practice in martial arts.

PURPOSE: Measure the effects of physical practice of two basic kickboxing kicks (side kick, and roundhouse kick) on reaction time, force output, movement time, kick angular velocity, and angular excursion of the kick. Examine degree of carry over by showing improvements on an unpracticed kickboxing kick (the front kick).

HYPOTHESIS: Consistent practice of the two kicks would bring about favorable improvements to the variables mentioned above that those same improvements would carry over to the unpracticed kick.

SIGNIFICANCE: In the rehabilitation realm, whole practice is often used as a training paradigm. This is where, for example, to improve walking, the subject would walk. No other tasks would be used to train walking as it is thought there would be little carryover to the non-practiced task. This pilot study used electromyography to measure reaction time and electrogoniometry to measure quality of the movement and found that found that reaction time of the Tibialis Anterior (TA) and Gluteus medius (GM) improved in the non-practiced front kick (Figure 1).

FORWARD THINKING: Since carryover of reaction time was found in our preliminary data, the question arises if this carryover could apply to other functional tasks as well. Might kickboxing training carry over into stair climbing or walking? If one body part is injured, could rehabilitation of similar movements that do not involve the injured part carry over to other rehabilitation tasks?

STUDENT INVOLVEMENT: Pilot data that was collected by a student has supported our hypothesis. Future research will include using more sophisticated means to track reaction time and movement quality (Vicon motion analysis system) and measuring the performance of other functional tasks such as stair climbing. Students will recruit subjects, develop testing protocols, collect and analyze data. It is desired that larger numbers of subjects be recruited to add statistical power.

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PROJECT TITLE: "The effect of varying hip flexion angle on the torque production of the hip rotators"

FACULTY NAME: Andrew Starsky MPT, PhD, Clinical Assistant Professor, Physical Therapy

STUDENT NAMES: Erica Bleier, Shannon Knoblauch, Jessica Schmidt

INTRODUCTION

The human hip is a ball and socket joint that allows controlled triplanar movement which is utilized in many functional tasks such as ambulation. In particular, movement in the horizontal plane is seen in gait and pivoting in sport. Control of this horizontal plane motion has been implicated in patellofemoral pain as well, as poor control of the femur can increase stress on the patella. There are 21 muscles that cross the hip joint and control this movement.   Primary external rotator muscles include the gluteus maximus and several short rotators. Internal rotator muscles include the gluteus minimus/medius, tensor fascia latae, and the hip adductors. Modeling has shown that these rotators can change their internal moment arm with different positions in the saggital plane of the hip, some of them even transitioning from external to internal rotators with increased hip flexion.

SIGNIFICANCE

Clinically, strengthening of the hip rotator muscles is common in multiple conditions. Little thought is typically given to the saggital position of the hip when performing these exercises. Also, some patients with conditions such as Cerebral Palsy may walk with internally rotated hips, adding stress to other structures of the leg. Current therapy does not often address the saggital position of the hip with these patients. However, the saggital position of the hip may indeed have a strong influence on the torque production of the hip rotators.

FORWARD THINKING/INNOVATION

Preliminary data (Figure 1) shows a strong relationship between hip flexion angle and the maximal isometric torque production of the hip rotators. Specifically, as the hip flexion increases, the maximal torque of the hip internal rotators relative to the external rotators increases. This project proposes to analyze this relationship in both healthy subjects and subjects with cerebral palsy. The results of this study could drive clinical practice into more awareness of the saggital position of the hip when addressing the strength of the hip rotators. For example, a therapist working with a patient that has internally rotated femurs may want to focus on getting the hip into more extension. This may decrease the propensity for the hip to bias into internal rotation, and may even decrease the need to undergo corrective femoral derotation surgery.

STUDENT INVOLVEMENT

Physical Therapy students will recruit subjects, collect all the data on a Biodex isokinetic testing machine, analyze the data, and address clinical implications. A total of 30 healthy and 30 subjects with CP will be recruited for this project. Their hip torque and gait parameters will be assessed.

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PROJECT TITLE: "A Study of Racial Microaggressions Among Latina/os: The Consequences on Mental Health"
FACULTY NAME: Lucas Torres, PhD, Assistant Professor, Psychology
STUDENT NAME: Kelly M. Moore, MS, Doctoral Student, Clinical Psychology

INTRODUCTION

Given the rapid growth of the Latina/o population in the United States in recent years, research related to the mental health experiences and distress of Latina/os has emerged as a crucial area of study. Ethnic minority status itself has been determined to be a risk factor for various negative psychological outcomes. Nearly one-third of Latina/os experience a psychiatric disorder within the span of one year, most often mood disorders and substance use disorders[4]. Although the etiology and correlates of these disorders may vary, it has been found that being a member of a devalued group relates to mental and physical health disparities among racial/ethnic groups. Because of the current focus on policy issues related to immigration, there are sociopolitical implications for understanding the racial stress experiences of Latina/os more thoroughly. Experiences of race-related stress and discrimination are a persistent part of interpersonal interaction due to the heightened scrutiny of Latina/os in modern American culture.

SIGNIFICANCE

Racial discrimination, whether covert or overt, remains a salient experience for many ethnic minorities living in the United States as 41% of Latina/os surveyed reported a personal experience with discrimination[2]. The proposed study seeks to investigate a theoretical framework for the experiences and consequences of a form of discrimination termed *racial microaggressions*, a form of covert discrimination representing subtle, ambiguous insults or derogations toward members of racial/ethnic minority groups.[5] Because the experience of the discriminatory events may be elusive, the target may be left with unresolved thoughts and emotions related to the event, potentially causing psychological distress. Discriminatory events have been implicated in ethnicity-based psychological health problems[1], but it unclear how covert forms of discriminations may influence psychological distress. Because it has been hypothesized that the elusive nature of covert forms of discrimination may make them more psychologically harmful than overt forms[3], it is critical to understand how subtle forms of racism influence mental health. The overarching intention of this study is to understand the relevant psychological constructs and pathways involved in experiences of racial microaggressions among Latina/os and their influence on mental health.

FORWARD THINKING/INNOVATION

The study addresses gaps in the theoretical understanding of discrimination among Latina/os. Although previous research has demonstrated the negative influence of discrimination on mental health, there is a lack of understanding regarding the underlying mechanisms explaining why covert forms of discrimination are associated with negative mental health outcomes. The current state of research on racial microaggressions is largely anecdotal or qualitative. Further, much discrimination-based research has been conducted with African Americans. Therefore, the proposed study has important implications for understanding the experiences of racial microaggressions among Latina/os and their consequences on mental health. Beyond these theoretical and research implications, understanding these processes will offer insight into appropriate intervention and treatment, particularly for the community care of Latina/os. Components of the methodology is also innovative as it requires development of means of presenting a microaggression experience (i.e., by reading a vignette) and measuring associated responses as well as determining the utility of an unpublished quantitative measure of racial microaggressions.

STUDENT INVOLVEMENT

This study is intended as a primary component of Kelly M. Moore's doctoral dissertation. Preliminary data has been collected but greater sample size is required for sophisticated statistical analyses. Lucas Torres, PhD will act as academic advisor, providing guidance through the completion of this project. Ms. Moore will be the primary researcher of this study, responsible for collecting and analyzing data as well as interpreting and writing the results for the dissertation and for publication in academic journals. Undergraduate students involved in Dr. Torres' Mental Health Disparities Lab may also become involved in data collection and management procedures.

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PROJECT TITLE: Traumatic Stress Symptoms as a Consequence of Discriminatory Experiences within Latino Adults
FACULTY NAME: Lucas Torres, Ph.D., Assistant Professor of Psychology
STUDENT NAME: Leticia Galindo

INTRODUCTION

Recent research has found that not only is discrimination highly prevalent among Latinos living in the U.S., (Perez, Fortuna, &Alegria, 2008) but that these negative events are detrimental to the mental health of Latinos. To better understand the negative consequences of discrimination, Sanchez-Hucles (1999) suggested that the experience of racial discrimination is parallel to broader traumatic stressors. Traumatic stress symptoms include physiological hyperarousal, avoidance behaviors, intrusive thoughts, re-experiencing the event through nightmares or flashbacks, increased anxiety, and fear. Emergent research suggests that the experience of discrimination is equivalent to a traumatic event given that victims of discrimination can develop traumatic stress symptoms (Carter, 2007). Applying a traumatic stress paradigm to understand the relationship between discrimination and mental health is highly innovative and has several theoretical and practical implications.

SIGNIFICANCE

Perhaps as a result of the increased attention on immigration, 41% of Latinos surveyed reported an experience with discrimination (National Survey of Latinos, 2006). Given that Latinos are the largest ethnic minority in the U.S., it is imperative that clinical research examine the mechanism by which these negative ethnic-related experiences influences mental health. Although the idea of implementing a traumatic stress paradigm to discrimination has been discussed theoretically, few researchers have attempted to support the idea with qualitative or quantitative research. The purpose of this study is to identify the mechanism by which discrimination is associated with poor Latino mental health. That is, the current study will examine the extent to which traumatic stress symptoms mediates the relationship between discrimination and Latino psychological distress. Furthermore, the findings will determine the unique traumatic stress symptoms that are related to discriminatory events. This information is important to consider in a clinical setting when treating Latinos who are experiencing psychological distress as a result of or in association with discrimination. The traumatic stress paradigm can inform the interventions that are most suited for the Latino client and can help clinicians conceptualize their client's symptoms as traumatic stress in nature rather than attributing endogenous causes. Additionally, scientific evidence for a traumatic stress framework will provide a novel theoretical perspective to explain the underlying process by which discrimination impacts the mental health of Latinos.

FORWARD THINKING/INNOVATION

Recent years has seen an emergent direction of research that includes integrating psychological and physiological processes to understand the mental health problems resulting from negative life events. Research applying a traumatic stress framework to understand the link between discrimination and mental health is cutting-edge work with the potential to make significant contributions to the Latino mental health field. There remains a paucity of research examining the effects of discriminatory experiences on adult Latinos living in the U.S. let alone applying a traumatic stress paradigm. Given that the framework has already been presented theoretically it is necessary to conduct research that can further expand on the notion that discrimination is associated with traumatic stress symptoms which, in turn, leads to poor mental health. Based on these findings, future research can investigate further the physiological stress markers, such as cortisol levels, that are influenced by discrimination and other culturally-specific negative events.

STUDENT INVOLVMENT

Under the direction of Dr. Torres, Leticia Galindo will be responsible for recruiting participants, implementing data collection procedures, data entry, data analysis and interpretation, as well as dissemination of findings.

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PROJECT TITLE: "Nonlinear Estimation Based Prognostics of Inter-turn Faults in Induction Machines"

FACULTY NAMES: Edwin Yaz, Nabeel Demerdash (Dept. of Electrical and Computer Engineering)

STUDENT NAME: Fan Feng (Dept. of Electrical and Computer Engineering)

INTRODUCTION

Induction Machines (IMs) are some of the most used equipment in modern industry. Thus, diagnostics and prognostics of IMs are very important. In this work, "abcf" and "dqof" models were built to describe the IM stator winding inter-turn fault conditions. These prognostics require estimating both the states (in this case, states are fault current and currents in each phase) and the parameters at the same time. Thus, nonlinear estimation techniques will be introduced to reconstruct the currents in each phase, so that faults can be detected before it happens. The estimation result for the states will be compared with magnetic equivalent circuit simulation result.

SIGNIFICANCE

Winding inter-turn faults are some of the most common faults in IMs [1], [2]. The faults can be caused by overheating, over voltage, loosing winding, etc. Faults are usually inevitable, so it is very important that incipient faults can be detected before they happen.

FORWARD THINKING / INNOVATION

In previous research regarding this problem, a preliminary model of the machine and the extended Kalman Filter [3] were built. The result was close to acceptable based on certain simplifying assumptions regarding the parameters. First, an improved model will be developed. Then new algorithm involving a bank of linear Kalman Filters will be used to improve the results.

STUDENT INVOLVEMENT

The student will derive the new the "abcf" and "dqof" models of the IM, set up the new estimator using a bank of linear Kalman Filters and use Matlab/Simulink to perform simulations. Then, the new results will be compared to the old ones to see if there is any improvement.

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Keywords