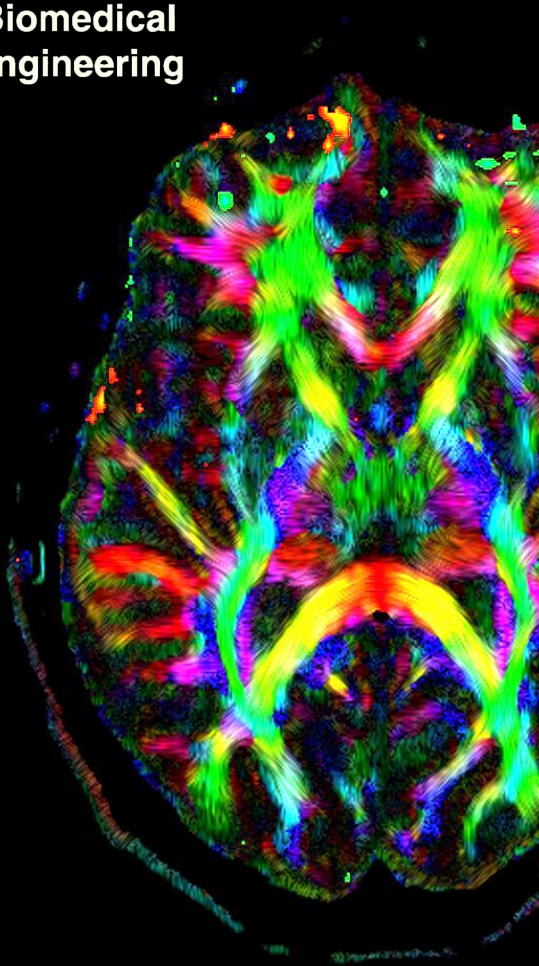
FIU | Biomedical Engineering

5th Annual Undergraduate Research Day

Friday, March 20, 2015



Keynote Lecture:

From Nanoneuroscience, Naoneurosurgery and NanoBioElectronics to Brain Policy

Babak Kateb, Ph.D.

Research Scientist, Department of Neurosurgery, Cedars-Sinai Medical Center, Beverly Hills, CA, Director of National Center for NanoBioElectronics, Founding Chairman of the Board of Society for Brain Mapping & Therapeutics (SBMT), President of Brain Mapping Foundation.

Presented by:

Department of Biomedical Engineering
Wallace H. Coulter Biomedical Engineering Distinguished Lecture Series

Engineering Center 2300, Florida International University
10555 W. Flagler Street, Miami, FL 33134

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Keynote Lecture by Babak Kateb, Ph.D.

"From Nanoneuroscience, Naoneurosurgery and Nano-BioElectronics to Brain Policy"

The field of Brain Mapping has evolved rapidly in the last few years. The field went from being defined by imaging to include imaging, molecular/cellular and nano level mapping with detailed genetic and connectomic mapping. Today the Society for Brain Mapping & Therapeutics (SBMT) defines Brain Mapping as the study of the anatomy and function of the brain and spinal cord through the use of imaging (including intra-operative, Microscopic, Endoscopic and Multi-Modality imaging), Immunohistochemistry, Molecular & Optogenetics, Stem Cell and Cellular Biology, Engineering (material, electrical and biomedical), Neurophysiology and Nanotechnology. In 2013, SBMT, Brain Mapping Foundation (BMF), along with a few other organizations successfully helped the White House to formulate Brain Research through the Advancing Innovative Neurotechnologies (BRAIN) initiative. The initiative is aimed at increasing our understanding of brain structure and function from imaging to nanoscale. While this initiative is a great step toward the right direction, it has shortcomings in respect to facilitating translation. This is why SBMT has established the G20 World Brain Mapping and Therapeutics to complement the BRAIN initiative. BMF has been funding major partnerships with NASA in order to integrate Nanotechnology, device, imaging and cellular and molecular therapeutics. This presentation will define the nanoneuroscience, nanoneurosurgery and nanobioelectronics and their relationship with brain mapping and brain policy, which will impact the field while producing few examples.

Program:

9:30 am	Student Workshop- Dr. Toni Litorja (EC 2300)
11:00 am	Poster Set Up (Panther Pit)
11:30 am	Lunch for student presenters (EC 2680)
12:30 pm	Poster Session (Panther Pit)
4:00 pm	Distinguished Lecture- Dr. Babak Kateb (EC 2300)
5:30 pm	Poster Awards (EC 2300)
6:00 pm	Reception (Panther Pit)

Morning Lecture by Toni Litorja, Ph.D.

"Challenges, Pathways and Benefits of Standards in Biomedical Optical Measurements"

Many optical devices are assembled for bedside research investigations, especially now with the miniaturization of biophotonic components. Optical techniques offer speed, flexibility, versatility and familiarity, as many are based on accepted benchtop bioanalytical measurements but are challenging to implement, and to do so reproducibly. However, for these prototypes to translate to the marketplace and routine clinical use, repeatability and reproducibility have to be proven in order to gain the confidence of the end-users. Measurement standards, through instrument calibration and use of reference materials, are the tools by which measurement reliability can be established. This presentation will discuss the pathway by which some common clinical device measurements are traceable to the international system of units (SI), some that are not, and concepts for bringing SI-traceability to new techniques to usher their translation into the clinic.

Toni Litorja has been a research chemist at the National Institute of Standards and Technology's Sensor Science Division since 2001. She obtained her Ph.D. in Physical Chemistry from Northwestern University in 1996, then worked as a postdoctoral fellow at Argonne National Laboratory's Surface and Dynamics Group. She joined NIST as a National Research Council (NRC) postdoctoral fellow at NIST's Surface and Microanalysis Science Division.

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P1: Quantitative Analysis Balance Control using Inertial Measurement Unit (Accelerometer and Gyroscopes)

Agnes Arrinda, Juan Loayza, Oscar Gil, Juan Pham, Anil Thota, Ranu Jung
Department of Biomedical Engineering, Florida International University

Abstract

Around 1 million people were living in the United States in 2005 with lower limb loss caused by amputations due to pathological conditions or trauma. A significant number of amputees decide to get a prosthesis to be able to perform activities of daily living (ADL). Balance, a key part of ADL, is needed for standing, walking, turning, etc. A prosthetist make adjustments to the prosthetic leg to be fitted to amputee. The current method used during prosthetic fitting alignment is not quantitative. Prosthetic alignment is accomplished through iterative adjustments of several parameters by the prosthetist, who uses the verbal feedback from the amputee and previous experience to find the best fit. This method is subjective and the best fit may not be achieved. It is hypothesized that objective measures derived from quantitative assessment of neuromechanical control of motor task, such as balance, during the prosthetic limb fitting iterations may aid prosthetists in achieving a good fit. Data will be collected from 20 lower limb amputee subjects and 20 able-bodied subjects. This balance test will record data from electromyography (EMG) and the lumbar kinematic sensor (APDM Inc.) from both groups of subjects for comparison. Three trials of two conditions, eyes open and eyes closed, will be performed for 30 seconds. The measurements obtained for analysis are acceleration and angular velocity. These are used to find angular rotation, jerk, and confidence circle and ellipse area. A double link model will be added to the analysis in the future. The preliminary raw data from one able-bodied subject was analyzed. The experimental methodology was developed. More data from able-bodied and lower limb amputee subjects will be collected to arrive to a statistical meaningful conclusion about a goodness of fit quantitative assessment.

P2: Paper-Based Cell Culture Platform for Rapid Antibiotic Assay

Alex Williams, Chen-Zhong Li
Department of Biomedical Engineering, Florida International University

Abstract

Simple, disposable, and portable devices for culture assays can be used in low-resource environments without the need for an aseptic laboratory infrastructure. Paper-based platforms can replace current in vitro assays including cell assays, and thus can overcome the high cost of microtiter plates. In recent years, paper has been successfully demonstrated as a novel 3D platform for both eukaryotic cell culture and for prokaryotic cell culture. The utilization of controlling and manipulating cells, both in cultures and individually, is usually amplified if the basis for analytical and distributive processing is accomplished at reduced levels such as the micro or nano-level.
For this investigation, the patterned barriers (e.g., 96-zone and 384-zone formats for high-throughput use) will be created on paper using wax printing. The microfluidic system along with cell culture zones will incorporate wax printing, which will be heated onto the paper using a standard hot plate. This will accentuate hydrophilic and hydrophobic sections of the device, which will define the borders that contain the cell lines. The patterning of the device will call for zones to culture the bacterial cells while the media is exchanged throughout the zones using the stacked zones as microchannels. Varying quantities of the wax-printed paper will be stacked on top of one another within the device to simulate the layers of tissue found within a 3D environment. The growth rate and apoptotic rate of the suspension across each zone and layer as well as the flow of the media throughout the device, in accordance with the growth rate, will also be investigated. In such a 3D device, bacterial growth rates, antibiotic responses, and phage amplification will be compared to those observed on agar plates or in shaking cultures. Further, the device will be used for the sensing of the resistance of bacteria in biological, environmental, or foodborne samples and could be tailored for specific applications.

P3: Endothelialcellresponses to Balloon Aorticvalvuloplasty

Angie Estrada*[1], Glenda Castellanos[1], Lilliam Valdes-Cruz[2], Steven Bibevski[2], Frank Scholl[2], Sharan Ramaswamy[1]
[1]Department of Biomedical Engineering, Florida InternationalUniversity
[2]Joe DiMaggio Children's Hospital

Abstract

Every year, more than 35, 000 newborns in the U.S. suffer from congenital heart defects. Critical neonatal aortic valve stenosis (NAVS) in particular is a medical emergency. Typically, balloon aortic valvuloplasty (BAV) is performed to ease the flow of blood. However, restenosis is very common. It is therefore of interest to identify valve tissue remodeling responses to its hemodynamic environment after balloon intervention. At the cellular scale, valve endothelial cells (VECs) are the first to sense mechanical signals which leads to a cascade of autocrine activity as well as paracrine processes with valve interstitial cells (VICs). To understand VEC response to flow profiles following balloon intervention, we will expose VECs to a clinically representative flow waveform depicting both post-balloon and normal states. From these experiments we will evaluate the changes in VEC intracellular structural protein structure and resulting gene expression. Subsequent comparisons between normal and post-balloon groups will delineate potentially abnormal VEC responses which could then be linked to the underlying causes for rapid restenosis following BAV.

P4: Novel in-vitro Model of Epilepsy Using iPSC Techniques

Anthony Giordano, Wei-Chiang Lin
Department of Biomedical Engineering, Florida International University

Abstract

Epilepsy is a neurological condition characterized by the onset of unprovoked seizures. A seizure is a neurological condition caused when neurons get excited at the same time causing them to rapidly fire. It is believed that 40% of epilepsy is caused by genetic mutations and to prove this the experiment is working on creating an in vitro model of epilepsy using iPSC techniques. IPSC is where a cell is converted from the type it is into a stem cell, which can differentiate into any type of cell while being able to renew itself. In this experiment we have obtained neural tissue from chemically induced epileptic rats and then will convert them into stem cells using iPSC and regrow them in a petri dish. It is hypothesized that the genetic mutations present in the epileptic tissue will also be present in the newly grown neurons and astrocytes in the petri dish. To validate the model the project will utilize Western Blot and RTPCR as well as numerous neurological measurements such as microelectrodes and voltage dyes to prove that the neural tissue has abnormal electrical activity indicating epilepsy.

P5: A Methodology for "in real-time" Identification of Psychological Conditions in Children with ASD

Celine Wassaf[1], Alberto Zuniga[1], Raul Camarca[1], Tommaso Benigni[1], Aylin Acosta[1], Aleida Lanza[2], Deborah Safko[2,3], Christine Lisetti[1], 1Jorge Riera
[1]Florida International University
[2]Autism-U
[3]Infinite Personal Possibilities

Abstract

Autism Spectrum Disorder (ASD) is a developmental condition that involves severe deficits in a person's ability to interact with others. Early intervention with Applied Behavior Analysis (ABA), a conditioning learning method, can help the individual significantly improve their social behaviors. The ultimate goal of this project is to incorporate an intelligent video-game which help improve the outcomes of current ABA interventions for ASD. Video games with biofeedback have been used to improve concentration in ASD children. However, there is no precedent in developing a video game that uses bio-feedback to maximize social integration of ASD children. The video-game will be controlled in real-time using biofeedback from each child. The phase-I of this study is to develop a methodology that allow us to determine the psychological state in these children based on several physiological measurements.

P6: Systematic Monitoring of Wound Healing Using a Hand-held Near-infrared Optical Scanner

Elizabeth Solis, Stephanie Gonzalez, Suset Rodriguez, Anuradha Godavarty
Deparment of Biomedical Engineering, Florida International University

Abstract

According to the American Podiatric Medical Association, about 15 percent of the patients with diabetes would develop a diabetic foot ulcer. Furthermore, foot ulcerations leads to 85 percent of the diabetes-related amputations. Foot ulcers are caused due to a combination of factors, such as lack of feeling in the foot, poor circulation, foot deformities and the duration of the diabetes. To date, the wounds are inspected visually to monitor the wound healing, without any objective imaging approach to look before the wound's surface. Herein, a non-contact, portable handheld optical device was developed at the Optical Imaging Laboratory as an objective approach to monitor wound healing in foot ulcer. This near-infrared optical technology is non-radiative, safe and fast in imaging large wounds on patients.

The FIU IRB-approved study will involve subjects that have been diagnosed with diabetes by a physician and who have developed foot ulcers. Currently, in-vivo imaging studies are carried out every week on diabetic patients with foot ulcers at two clinical sites in Miami. Near-infrared images of the wound are captured on subjects every week and the data is processed using custom-developed Matlab-based image processing tools. The optical contrast of the wound to its peripheries and the wound size are analyzed and compared from the NIR and white light images during the weekly systematic imaging of wound healing.

P7: Cell Surface Mechanosensing

Elizabeth Gallardo, Adrian Pegoraro, David Weitz
Department of Biomedical Engineering, Florida International University

Abstract

On polyacrylamide gels, cells change their spread area in response to different stiffness substrates; however, on polydimethylsiloxane (PDMS), cells spread maximally regardless of substrate stiffness. It has been suggested that surface chemistry alone can explain this behavior on PDMS. Our results show that a yet unidentified property must also be playing an important role. Using polyacrylamide gels on PDMS, we find that cells increase their spread area as polyacrylamide gels become thinner regardless of the effective substrate stiffness of the composite material. We speculate that cells sense and respond to the effective porosity of their environment.

P8: Gene Expression on Freshly Isolated Vascular Cells

Jiali Lei*, Daniel Rodriguez, Nikolaos Tsoukias
Department of Biomedical Engineering, Florida International University

Abstract

Gene expression is the process by which genetic specification is instructed to synthesize functional gene products such as proteins, enzymes, hormones, and receptors to suffice the essentials for the cells. As the selective permeable and anticoagulant barrier lying between vessel wall and blood, endothelial cells and their membrane ion channels are valuable in the analysis of cardiovascular diseases such as hypertension, which smooth muscle cells play an important role in muscle contraction with their calcium influxes. Scrutinizing the ion channel expressions in the freshly isolated cells yields a better understanding of the disease state in a more vivid cellular and microbiological environment. ***Methods:*** In order to synthesize genes for analysis of gene expression, reverse transcription polymerase chain reaction (RT-PCR) is conducted by binding various primers to cDNA synthesized from cells or tissues. Those cells or tissues are obtained from enzymatic dissociation on the superior mesenteric artery from rats, which yields the endothelial cells and smooth muscle cells. Compared to the cultured cells, the freshly isolated cells through a technique associated with micro magnetic beads ensure more gene expressions and more efficiency of obtaining results. Furthermore, this sequence of experiments is carried out on both normotensive and hypertensive rat mesenteric arterial cells to observe the different gene expressions. ***Results:*** Increased calcium channel expression causes the vascular tone to increase, further causing blood pressure to increase. Theoretically, reducing the potassium channel activity should cause an increase in blood pressure; however, animal model study shows the opposite outcome. Calcium-activated potassium current and ATP-sensitive potassium channels, for example, show increasing trend in hypertension, which means that the increased potassium channel activity opposes hypertension as its compensatory mechanism. ***Conclusion:*** Overall, this research provides a better demonstration than those experiments that involve cell culture, and it yields a better result in terms of more gene expressions on normal and hypertensive cells. The incorporation of micro magnetic beads delivers more efficiency on cell isolation. The results also assist to build a better therapeutic treatment for hypertension by targeting specific ion channels such as blocking calcium channels or opening potassium channels.

P9: Modeling Light-Activated Calcium Signaling in Astrocytes

Josue Santana, Lakshmini Balachandar, Jorge Riera Diaz
Department of Biomedical Engineering, Florida International University

Abstract

A novel technology known as optogenetics seems to be a promising tool for the study of numerous biophysical processes at the cellular level. Modeling the functioning of *channelrhodopsin-2* (*ChR2*), a light-gated ion channel, and its role in the stimulation of calcium ( ) signaling in astrocytes by the use of optogenetics was the main purpose of this research project. In the past, computational models have been implemented to describe the role of *ChR2* in different types of excitable cells ranking from single neurons to cardiomyocytes. However, there have not been any previous attempts to model this type of retinylidene proteins in astrocytic glial cells, which in the contrary, are not electrical excitable. A 4-state transition rate model primarily developed to mimic the biexponential photocurrent decay kinetics of ChR2wt (Stefanescu et al., 2013) was effectively used to develop a computational model capable of describing this behavior in astrocytes; MATLAB served as our main tool to address this challenge. Due to the stiffness nature of the differential equations from the 4-state model, the ode45 solver had to be employed in order to obtain accurate quantitative results for our modeling work. Preliminary results provided us with the stimulated signaling response of a single astrocyte when subjected to different pulse durations and light intensities. The outcome suggests that the number of calcium signaling spikes is going to be significantly higher when pulse durations of 0.3 seconds were used along with a light intensity ranging between
0 and 2.4 candela (cd). Moreover, further studies must be conducted in order to verify if our computational results are consistent with experimental studies that are being currently conducted by the Neuronal Mass Dynamics Laboratory under the supervision of Dr. Jorge Riera Diaz. Lastly, the intracellular signaling in astrocytes constitutes a paramount area of research due to the role of this ion in numerous biochemical events within biological systems. It is believed that such studies may contribute to provide us with insights about the functioning of numerous inflammatory mechanisms related to the occurrence of epileptic seizures.

P10: Biomechanical Analysis of 180 Degree Turns Using Inertial Measurement Unit

Juan Pham, Juan Loayza, Agnes Arrinda, Oscar Gil, Anil Thota, Ranu Jung
Department of Biomedical Engineering, Florida International University

Abstract

Turning without losing balance is crucial to perform day to day tasks. Turning deficits manifest in individuals with movement disorders (e.g Parkinson's disease). Amputees often find it difficult to negotiate turning with prosthetic leg. The deficits in turning leads to falls. A detailed biomechanical analysis study of turning is needed to understand the various aspects of turning in amputees. The knowledge gained will be used to help developing strategies to overcome the difficulties in turning and prevent falling. For an amputee receiving a new prosthetic leg, adjustments to the prosthetic leg is needed to fit the amputee properly and to perform activities of daily living efficiently. Evaluation and quantification of turning biomechanics in amputees will allow us in suggesting better fitting adjustments to reduce the risk of fall during turning.

P11: Practicing Preksha Meditation Affects Cognitive and Pulmonary Function

Laura Anderson[1], Gabrielle Roman[1], Samani Unnata Pragya, M.A., M.Phil.[2], Amy K. Starosciak, Ph.D.[1], Mohamed Abdelghani, Ph.D.[1], Noah DeLone[1], Oceanna Marr[2], Ranu Jung, Ph.D.[1]
[1]Department of Biomedical Engineering, Florida International University, Miami, FL,
[2]Department of Religious Studies, Florida International University, Miami, FL

Abstract

Meditation has been used as a means of increasing relaxation, cognitive ability, emotional well being, and health. It is hypothesized that by learning the correct method of Preksha Meditation a significant change will be observed in the subject's pulmonary and cognitive function. Physiological and cognitive testing was performed on 47 randomly selected university students. The tests were performed before the meditation session began as well as after the last meditation session was completed. Participants were trained in one of two meditation styles for 9 weeks. In each case, the meditation session lasted approximately 20 minutes. At the end of 9 weeks, subjects practiced there taught style of meditation while EEG was recorded, followed by post assessment tests for cognitive function that included the Connors test for attention, Automated Working Memory Assessment (AWMA) , and PANAS (Positive and Negative Affect Schedule). Pulmonary function assessments were performed utilizing the MircroLife PF 100 to measure Peak Expiratory Flow and the EasyOne Plus Frontline Spirometer to measure lung function. Cognitive and pulmonary test data were analyzed using SPSS software to determine if any significant changes were observed in respiratory or cognitive ability. To measure EEG, a recording cap with 64 Ag-AgCl electrodes in the international 10/20-configuration scalp (Waveguard 64 cap, ANT-Neuro, Netherlands) was placed on the head and electrode gel was used to make contact with the scalp. The EEG signals were analyzed (ASA Software, ANT-Neuro) by performing a Fast Fourier Transform (FFT). Preliminary results of the PANAS test indicated that some participants reflected a significant decrease in their overall negative emotional state while the AWMA indicated an enhancement in memory. No significant improvement was seen from the Connors attention test nor for any of the pulmonary assessments. In the EEG analysis, theta and beta but not alpha waves were seen to have an increase from the baseline recording. These results indicate that Preksha meditation brings forth a neutral emotional state while enhancing working memory.

P12: Developing a Dynamic Biomechanical Model of the Knee Using 3D Printing

Luai Mustafa, Ranu Jung
Department of Biomedical Engineering, Florida International University

Abstract

Patellofemoral tracking disorders comprises a group of conditions that result in abnormal tracking of the patella on its femoral groove (trochlea). Pain caused by patellofemoral disorders is one of the most common diagnoses in sports medicine and is responsible for about 25 to 40 percent of all knee problems seen in sports injury clinics (O'Connor, 2015). The causes are largely congenital, including an abnormally long patellar tendon (patella alta), shallow trochlear groove, and flattened or tilted patella, among others (Shubin Stein, 2013). It can lead insidiously to patellofemoral arthritis, but can also lead to acute traumatic events such as transient dislocation of the patella or tear of the medial retinaculum. Patients may suffer anterior knee pain or mechanical symptoms like clicking of the joint. Orthopedists may address this condition with physical therapy, quadriceps strengthening, taping/bracing, or, as a last resort, surgery. Diagnosis of the condition is not always clear, and physicians turn to imaging studies (radiography, CT, or MRI) for clarity. Our project seeks to augment knowledge of this condition by producing a 3D printed model of a human knee that can be flexed and extended to simulate the biomechanical action of the patient's knee using data obtained from CT imaging. For the model to be useful in the medical field it must be able to demonstrate accurate patellofemoral tracking and the procedure must be easily replicated for future patients.

P13: Understanding Sit-To-Stand Biomechanics Using Accelerometer and Gyroscopes

Oscar Steven Gil, Juan Loayza, Agnes Arrinda, Juan Pham, Anil Thota, and Ranu Jung
Department of Biomedical Engineering, Florida International University

Abstract

Lower extremity amputation is the most common level of amputation in both civilian and military population. The goals of providing lower extremity prosthetics devices are to allow the person to achieve basic motion, and progress to a variety of more advanced activities such as jogging. There are two main criteria for determining the timing of fitting a prosthesis. The first is that the residual limb is completely healed, and the second is that the amputee has enough stamina and body strength necessary to hop 50 to 100 feet using a walker. The prosthetic fitting process is highly variable among the prosthetists and subjective due to the lack of objective measures that quantify the quality of the prosthetic fit. It is believed that alignment parameters that achieve a good prosthetic fit improve overall balance during standing, gait symmetry between the sound limb and the prosthetic limb, and reduces jerkiness. The main goal in this study was to able to tunderstand the effect of changes in prosthetic limb fitting parameters on sitting and standing during TUG. Quantitative assessments were performed by acquiring kinematic data (APDM) and muscle activity data (EMG) from the amputees and able-bodied subjects using commercially available wireless mobile data collection units (sensors) for each combination setting of prosthetic fitting parameters. In conclusion, the quantitative assessment of neuro mechanical control of motor task during the prosthetic limb fitting iteration will provide the prosthetist an objective measure of the quality of fit and thereby aid them to achieving in achieving a quality fit.