FIU | Biomedical Engineering
Florida International University

7th Annual Undergraduate Research Day

Friday, March 3, 2017

Featuring a lecture by:

Jonathan P. Vande Geest, Ph.D.
Professor
Department of Bioengineering
University of Pittsburgh

"Vascular Medical Device Development in the Soft Tissue Biomechanics Laboratory"

Presented by:
Wallace H. Coulter Biomedical Engineering Distinguished Lecture Series
FIU Department of Biomedical Engineering

Florida International University, Engineering Center 2300
10555 W. Flagler Street, Miami, FL 33174

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About the Keynote Speaker:

Jonathan P. Vande Geest, Ph.D.

Dr. Vande Geest is a Professor of the Department of Bioengineering at the University of Pittsburgh. He received a Bachelor of Science in Biomedical Engineering from the University of Iowa and received his Ph.D. in Bioengineering from the University of Pittsburgh. Dr. Vande Geest is a member of the Biomedical Engineering Society (BMES), the American Society of Mechanical Engineers (ASME), the Association of Research in Vision and Ophthalmology (ARVO), the American Heart Association (AHA) and the American Physiological Society (APS).

In 2013, Dr. Vande Geest was awarded the Y.C. Fun Young Investigator Award, which recognized individuals demonstrating meaningful potential to make significant contributions to the field of Bioengineering. In 2015, he became Chair of the ASME Bioengineering Division Solids Technical Committee. Dr. Vande Geest leads the Soft Tissue Biomechanics Laboratory (STBL), where novel experimental and computational bioengineering approaches are developed and utilized to study the structure function relationships of soft tissues in human growth, remodeling and disease.

About the Presentation:

Cardiovascular disease remains as one of the leading causes of death in the United States. Advances in bioengineering, provide a unique opportunity to advance the field of medical devices as it pertains to treatment of cardiovascular disease. These include advances in additive manufacturing, imaging, cell mechanobiology and computational optimization. This research presentation will explore how such advances have been used in the Soft Tissue Biomechanics Laboratory to develop next generation medical devices for treatment of cardiovascular disease.

Program:

8:30 am	Breakfast Reception (EC 2300)
9:00 am	Seminar: Jonathan P. Vande Geest, Ph.D. (EC 2300)
11:30 am	Lunch Reception (EC 2300)
12:00 pm	Undergraduate Student Poster Presentation (EC 2300)
4:00 pm	Open Forum on Medical Device by Jonathan P. Vande Geest, Ph.D. (EC 2300)
5:30 pm	Award Ceremony (EC 2300)

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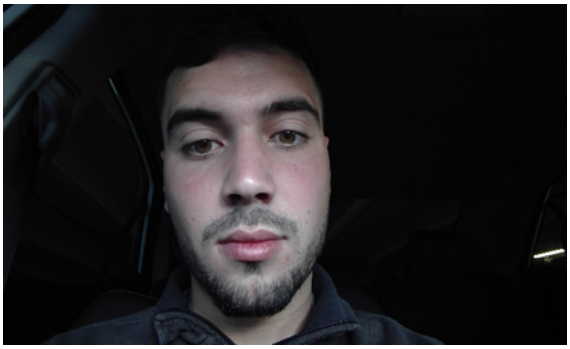
Irritative zones in focal cortical dysplasia: an EEG-fMRI case study

Authors

Fernando Gonzalez, Byron Bernal MD, PhD., Pedro A. Valdez-Hernandez PhD., Jorge J. Riera PhD.

Major Adviser Jorge J. Riera



Abstract

In the absence of seizures, epileptic patients present the so-called Interictal Epileptiform Discharges (IEDs) in their EEG recordings.

IED-based fMRI analysis has been successfully used for locating brain regions responsible for epileptic seizures. This is very important to non-invasively aid the pre-surgical planning for the extraction of the epileptic foci, specially in focal cortical dysplasia, where it is usually difficult to locate the epileptic region by means of conventional clinical tools. However, there is a remarkable lack of clinical protocols using this approach in the United States.

In this work we present the first case of a multi-institutional pediatric protocol (IRB #) implemented in Miami, Florida. Moreover, we propose to include the analysis of EEG source imaging (ESI) of IEDs, so far not taken into account in these types of protocols in spite of the high temporal resolution of this method.

Our fMRI activation was located near the calcarine fissure, in accordance with other conventional methods used in the clinical setup. This result was also reproduced by ESI.

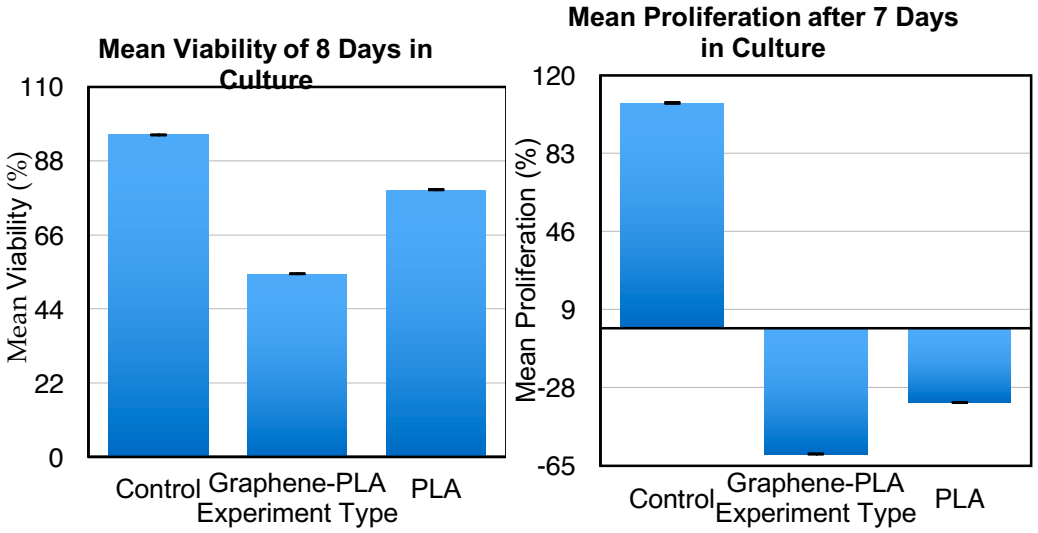
Interestingly, ESI activation also reveals an alternative putative epileptic region in the parietal cortex.

Adipose Stem Cell Culture Efficacy on Graphene-Polymer Composite Substrates

Authors

Nidhi Suthar, Brittany Gonzalez, Daniela Montero Zambrano, Jenniffer Bustillos, Pranjal Nautiyal, Archana Loganathan, Benjamin Boesl, Arvind Agarwal, Sharan Ramaswamy,

Major Adviser Dr.Sharan Ramaswamy



Abstract

It has been hypothesized that graphene can influence stem cell attachment, proliferation, and differentiation towards osteoblasts. This property is highly desirable since it may promote faster healing and reconstruction of bone defects. Graphene polymer composite can facilitate cell growth and differentiation of the cells depending on specific cell-to-substrate stiffness interaction.

An attractive feature of graphene, which has properties that possibly tailored with polymers to yield scaffold properties desirable for tissue engineering. At the same time graphene retains high strength, which is important for musculoskeletal application.

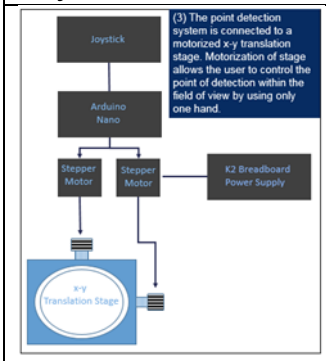
While graphene-polymer composites are promising for tissue engineering, there are nonetheless concerns about toxicity. In this project, canine adipose-derived mesenchymal stem cells were seeded on a graphene-PLA (poly-L-lactic acid) composite scaffold to test for viability and proliferation. Our results showed both graphene-PLA composite and PLA-only scaffolds had lower viability and proliferation than the control-viability was 95%,54.4% and 79.4%. The cell growth or proliferation was found to be 106.9%, -59.6% and -35.1%. It can be concluded that both scaffolds contain cytotoxic components. To minimize toxicity care and more comprehensive sterilization of raw materials is needed. Implementation of these precaution is currently being incorporated into on-going investigations in our laboratory.

Hybrid Spectroscopy Imaging System for In Vivo Tissue Investigation

Authors

Juan Giraldo; Wei-Chiang Lin, PhD

Major Adviser Wei-Chiang Lin, PhD



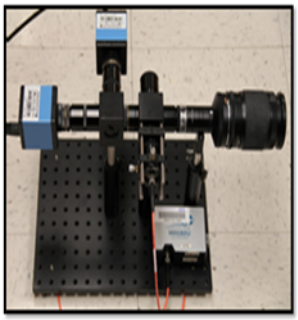
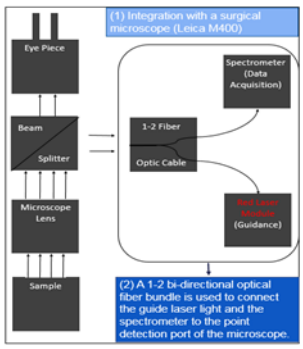
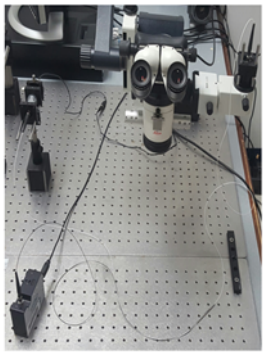
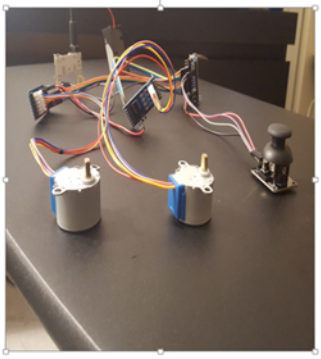


Figure 1: The prototype hybrid spectroscopy imaging system developed and built by Dr. Wei-Chaing Lin and Dr. Yinchen Song







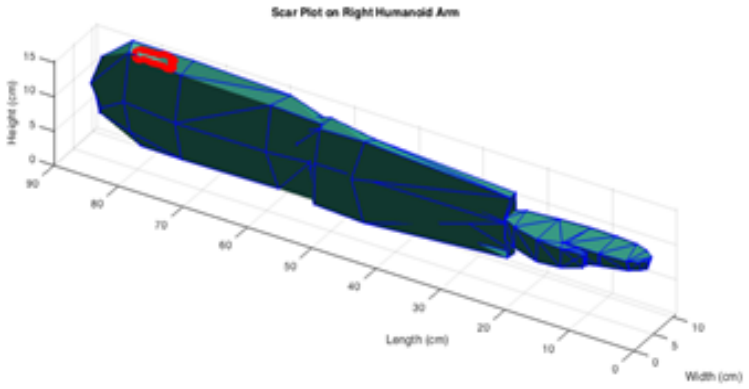
Abstract

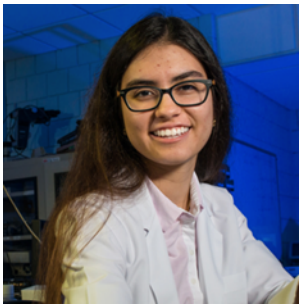
Optical properties are highly useful for the study of tissue functionality, tissue injury, and tissue pathology due to the fact that they share a direct relationship with structural and compositional characteristics. Therefore, these properties can be beneficial during In-vivo tissue investigation. In this study, improvement of a hybrid spectroscopy imaging system was carried out in order to facilitate and expedite its use while also allowing integration with a surgical microscope. The first improvement was full-integration of the spectroscopy imaging system into a surgical microscope in order to allow Intra-operative use. Moreover, incorporation of an aiming mechanism for the point detection system was employed in order to guide the point where data is being collected. Automation of site selection process for the point detection system was implemented in order to facilitate and expedite its use. Improvements were developed in Dr. Wei-Chiang Lin's lab. Further development of the system including incorporation of laser Doppler mechanism and laser speckle imaging mechanism will be done in order to measure blood flow. In order to further improve the imaging system, a motorized scan of a user-specified area will also be implemented in the future. Finally, In-vivo animal testing will be done in order to test the performance of the system.

Integration of Coordinate Measuring Machine (CMM) for Quantification of Scar Dimensions in 3-D Space

Authors
Nicole Sevilla, Mariacarla Gonzalez, Joseph Chue-Sang and Jessica Ramella-Roman

Major Adviser Dr. Jessica Ramella-Roman





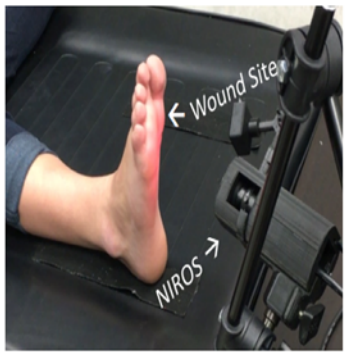
Abstract
The subjective nature of scar assessment scales impairs the physician's ability to properly monitor a scar over time. The Vancouver Scar Scale (VSS) is the most widely used scar assessment scale, consisting of 4 evaluation parameters: height, pliability, vascularity, and pigmentation. During clinical evaluation, the VSS scores height from 0 (flat) to 3 (higher than 5 mm), but ignores important metrics such as the scar's dimensions or its position relative to the body [1]. Quantification of scars becomes critical when presented with burn victims, where the prevalence of hypertrophic scars (HTS) is high among adults (67%) and children (87%) [2]. HTS are painful and create functional issues for the individual; therefore, accurate evaluation to provide proper treatment is necessary. Introduction of a portable, Coordinate Measuring Machine (CMM), (FaroArm, Lake Mary, Florida, United States, for collection of 3-D position data during scar evaluation helps to provide an objective evaluation of a HTS. The CMM allows the user to collect the length, height, and relative roughness of a scar with a resolution of 0.3 mm and repeatability of 0.024mm. To ease data collection, an easy to use general user interface (GUI) was designed to provide the user with a customizable reference humanoid body with modifiable body parts that can be adjusted to the patient's measurements before scar data collection with the CMM [3]. Consequently, the GUI displays the scar's relative position and dimensions on the humanoid body in real-time, serving later as a reference to the clinician of the patient's scar history.

Non-Contact Optical Imaging of Diabetic Foot Ulcers

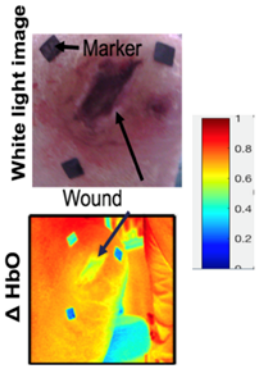
Authors

Cristianne Fernandez, Rebecca Kwasinski, Kevin Leiva, Richard Schutzman, Edwin Robledo, Penelope Kallis, Francisco Perez-Clavijo, Robert Kirsner, E.A. Pretto, Anuradha Godavarty

Major Adviser Dr. Anuradha Godavarty



Non-contact Imaging in the clinical setting



White Light image of wound and oxygenated hemoglobin sample plot

Abstract

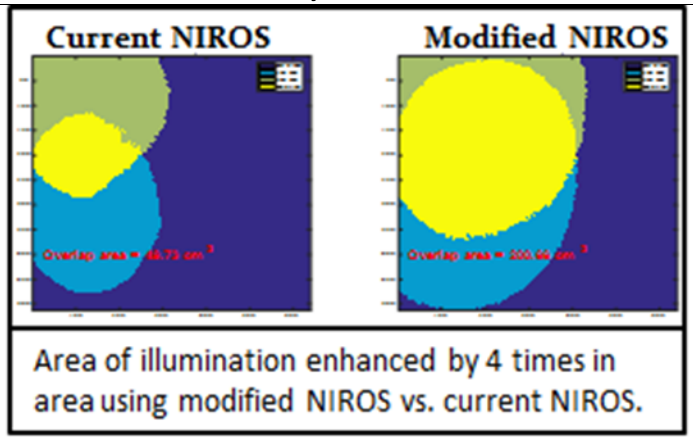
Diabetic foot ulcers (DFUs) affect approximately 25% of the estimated 29.1 million people diagnosed with diabetes. Patients with diabetic foot ulcers report an overall lower quality of life and a 5-year mortality rate of 40%. For doctors treating patients with these ulcers, it is important to evaluate the blood oxygenation in the wound and peri-wound regions, as oxygen is vital for wound healing. DFUs were imaged using a Near Infrared Optical Scanner (NIROS) that utilizes near infrared light at different wavelengths to obtain hemodynamic maps of the wound and peri-wound tissue. DFU patients from Podiatry Care Partners and the University of Miami Wound Care Center were imaged over several weeks. Hemodynamic maps of their wounds were obtained. The hemodynamic maps contain the changes in oxygenated (ΔHbO) and deoxygenated (ΔHbR) hemoglobin concentration of the wound and surrounding tissue. Results show that as the wound was healing, wound size became smaller and regions of reduced ΔHbO contrast between wound and peri-wound decreased. Increased oxygenation assisted in wound healing, as observed from the non-contact hemodynamic imaging studies of DFUs.

Modification of NIROS for Hemodynamic Imaging of Large Wounds

Authors

Edwin Robledo, Richard Schutzman, Mia L. Boloix, Anuradha Godavarty

Major Adviser Anuradha Godavarty



Abstract

A near-infrared optical scanner (NIROS) has been developed for non-contact sub-surface imaging of wounds. The current device, NIROS, employs a light source system of different wavelengths to image the same region during diabetic foot imaging studies. However, the illumination region by the system had produced small area of illumination and weak signal intensity, limiting the extraction of oxy- (HbO) and deoxy-hemoglobin (HbR) signals from entire areas of the wound and peri-wound. Herein, the source system of NIROS was modified to assess the changes in blood flow, in terms of changes in HbO and HbR, with maximum illumination between the different regions and increased intensity of illumination. The modified NIROS will allow imaging of larger wounds (> 8cm radius), such as venous leg ulcers and post-amputated diabetic foot ulcers, without adding to the patient time.

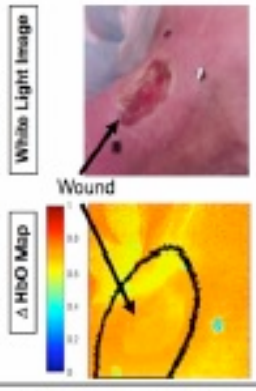
Hemodynamic Imaging of Venous Leg Ulcers

Authors

Rebecca Kwasinski, Cristianne Fernandez, Kevin Leiva, Richard Schutzman, Edwin Robledo, Penelope Kallis, Francisco Perez-Clavijo, Robert Kirsner, Anuradha Godavarty

Major Advisor: Dr. Anuradha Godavarty

NIROS set-up in clinic on an articulating arm



White light image and oxygenated hemoglobin map of wound and surrounding tissue

Abstract

Venous leg ulcers (VLUs) account for over 90% of all ulcer cases and it is estimated that ~ 1 in 50 people over the age of 80 are affected. Although the standard for clinical assessment is visual inspection, there is a need to develop a physiological approach that differentiates tissue oxygenation in and around the wound region. Herein, the Optical Imaging Laboratory (OIL) developed a portable, non-contact near-infrared optical scanner (NIROS) for sub-surface imaging of wounds. VLUs were imaged using NIROS on a weekly basis at the University of Miami Wound Care Center and Podiatry Care Partners Clinic. The near infrared images were used to evaluate the oxygenated and deoxygenated hemoglobin maps of the wound and the surrounding tissue. The oxygenation hemoglobin contrast between wound and its surroundings differed between healing and non-healing VLU imaged across weeks.

Use of Mueller matrix colposcopy in the characterization of cervical collagen anisotropy

Authors

Karla Montejo; Joseph Chue-Sang; Yuqiang Bai; Susan Stoff; Mariacarla Gonzalez; Jefferson Gomes; Nola A. Holness, PhD, RN; Amir Gandjbakhche, PhD; Viktor V. Chernomordik, PhD; Jessica C. Ramella-Roman, PhD

Major Advisor: Jessica Ramella- Roman

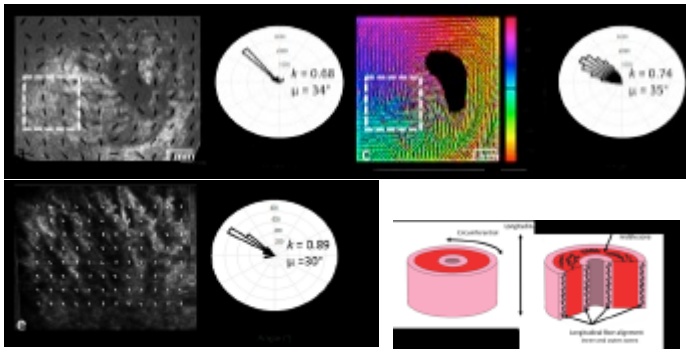


Figure 1 Paraffin embedded cervix orientation: : a) OCT C-scan, b) OCT CS, c) MMP orientation, d) MMP CS, e) SHG, f) SHG CS. Bottom right: Collagen arrangement in cervix

Abstract

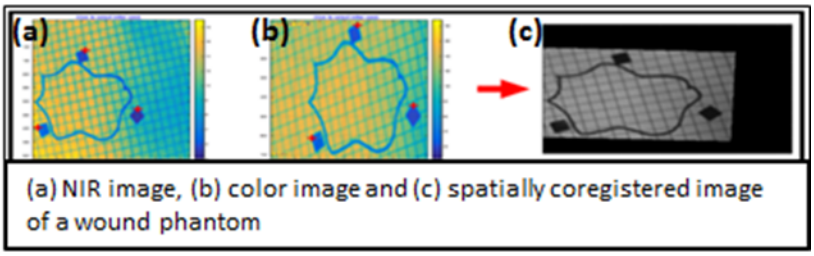
Preterm birth (PTB) presents a serious medical heath concern in both economically developed and developing nations. There is a high incidence of PTB ranging from 11%-15% worldwide, and 18% in Miami-Dade County. The causes of PTB are numerous, but always results in compromised cervical structure. Changes in cervical collagen bundle orientation and distribution may prove to be a predictor of PTB. Polarization imaging is an effective means to measure optical anisotropy in birefringent extracellular matrix tissue such as those rich in collagen. Non-invasive, full-field Mueller Matrix polarimetry (MMP) imaging methodologies, optical coherence tomography (OCT), and second harmonic generation (SHG) microscopy were used to assess cervical collagen content and structure in non-pregnant porcine cervices. The OCT imaging was used to verify the efficacy of the MMP in assessing changes in collagen orientation. Circular statistics were used to obtain kurtosis and mean orientation angle of polarization sensitive images. In vivo studies using a Mueller Matrix colposcope are underway. Further studies of cervical collagen orientation at different time points during remodeling are needed to understand if Mueller matrix polarimetry can effectively measure changes in cervical collagen orientation in pregnancy or disease.

Spatial Co-Registration of Visible and Optical Images

Authors

Richard Schutzman, Anuradha Godavarty

Major Advisor: Anuradha Godavarty



(a) NIR image, (b) color image and (c) spatially coregistered image of a wound phantom

Abstract

Formation of chronic ulcers can increase risk of infection and amputation. The progress of treatment is often evaluated by surface size and granulation without any understanding of physiological changes within the wound. In response, Near-Infrared Optical Scanner (NIROS) was developed and has been capable of differentiating healing and non-healing wounds based on optical contrast. In current clinical work, visible light images are captured alongside NIR images to try to compare surface wound characteristics to physiological changes, but the current configuration has resulted in poor co-registration of these images. A new system, which captured visible light images with a similar field of view as the NIR images, has been developed. The new NIROS has shown better co-registration, reduced variability and faster acquisition.

Propagation of Cortical Spreading Depression *Frequency and Velocity*

Authors

Daniel E. Rivera, Jorge Riera.

Major Adviser Dr. Jorge Riera

Abstract

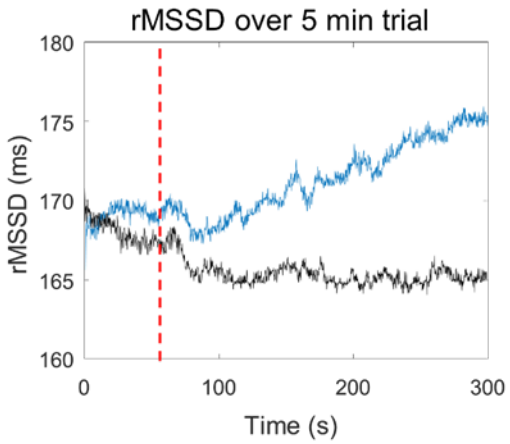
Cortical Spreading Depression (CSD) is a wave of complete neuronal depolarization that usually lasts for one to two minutes and can silence brain activity for a certain time after its occurrence. In this research project, LFP and MUA during CSD are measured using an A4x8 silicone based planar probe. To perform this experiment, two burr holes and two craniotomies are made in the skull of the rat. A screw is placed in each hole to serve as a reference and a ground electrode and the planar probe is inserted in the anterior craniotomy, 2mm above the bregma in the right hemisphere of the rat's skull to record changes in electric potential. To induce CSD propagation, 20-40 µL of various concentrations of potassium acetate (0.5M, 1M, 1.5M, 2M) are dropped on the posterior craniotomy. The different concentrations showed to cause an increase in the frequency of CSD events. By comparing the time the wave passed through the different shanks of the probe, the velocity of the propagation was measured and results show that the speed of the SD decreases as multiple CSD events occur. These results tell us more about the nature of CSD propagation and assist in making simulation models.

Effect of diaphragm pacing on heart rate variability in the rat model

Authors

Catarina Vale, Ricardo Siu, Ranu Jung

Major Adviser: Ranu Jung



Abstract

Heart rate variability (HRV) refers to the time variation between heartbeats. HRV has been linked with cardiovascular health. In spinal cord injuries (SCI), cardiovascular problems are a significant cause of morbidity. As the cardiovascular and respiratory systems are strongly coupled, diaphragm pacing (DP) via electrical stimulation to restore ventilation in SCI patients may have an influence on HRV. It is currently unknown what the effects of DP on HRV might be. Thus, it is necessary to elucidate what these effects would be.

An anesthetized rat model was used to assess the effect of DP on HRV. Arterial femoral blood pressure was recorded on one anesthetized rat for 5 trials. Each trial consisted of one minute of spontaneous breathing and four minutes DP. Beat intervals were obtained from systolic blood pressure intervals under both conditions. HRV was assessed using square root of the mean of the squares of differences between adjacent intervals (rMSSD), average interval period (AVNN), and standard deviation of the interval periods (SDNN). The data only showed significant differences from before stimulation to during stimulation for SDNN. Future work on this topic is aimed at expanding analysis and further examining the effect of DP on HRV.

Evaluating Best AAV Serotypes for in vivo Light-Based Intervention of Brain Astrocytes

Authors

Diana Borrego, [1] Lakshmini Balachandar, [2] Jeremy Chambers, [1] Jorge Riera Diaz

Main Advisor: Jorge Riera

Abstract

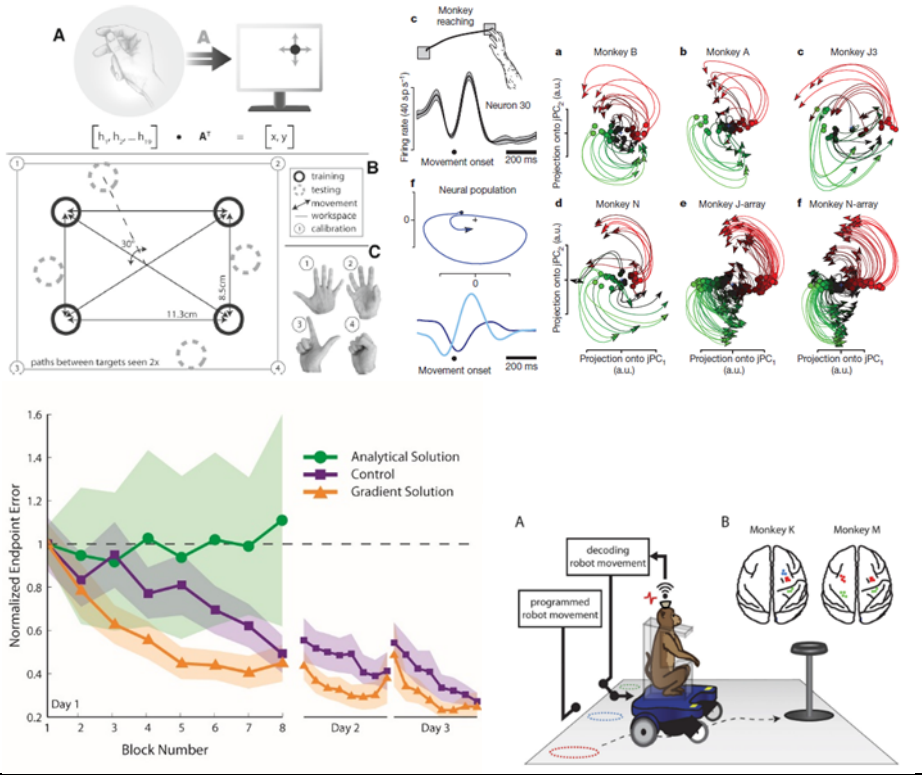
Optogenetics is a technique in neuroscience to control cells with light and has recently been used on electrically non-excitable cells like astrocytes. This involves introduction of a viral vector with a light sensitive protein which facilitates cationic influx into the astrocyte, upon activation. The viral construct of interest in our experiment is AAV-GFAP-hChR2 (H134R)-mCherry. However, to perform transduction in astrocytes, an evaluation of the serotypes of the optogenetic vector is necessary. This research is focused on finding the ideal serotype of the optogenetic virus in an *in vivo* rat model in order to apply it to an optogenetic technique. The plausible serotypes for the study were narrowed down to 1, 5 and 8, based on previous studies in the spinal cord and the rat brain targeting neurons. Stereotaxic surgeries were performed to introduce the virus into the cortex using microinjection. Post animal recovery, and after time window of viral expression, the animals were perfused. The validation of viral expression has been performed by post mortem histological analysis. From the preliminary data, serotype 8 of the virus shows promising transduction patterns in astrocytes, in terms of the highest spread, as well as the largest area of expression in the brain tissue. This evaluation would help us understand the expression of the gene conferring light sensitivity to the astrocytes. This approach would help gain control of astrocytes, which can be used to study various pathological conditions in the mammalian brain.

Brain-Computer Interfaces

Authors

Ninfamaria Arredondo-Walsh, Morits Luik, Dr. Zachary Danziger

Major Adviser: Dr. Zachary Danziger



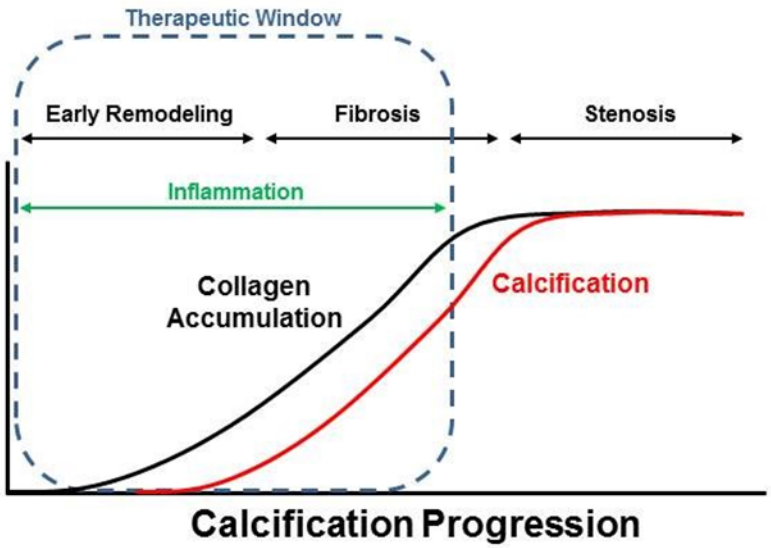
Abstract

A Brain-Computer Interface (BCI) allows for an alternate form of communication by way of a control system that does not depend on the typical peripheral nerves and muscles but utilizes the signals produced by the brain. However, there are limits to the extraction of neurological signals such as expense, the invasive nature of the experimental set-up, and voluntary participants. Therein lies a solution of using a model system: the dynamics of the human hand. By using the model system of the hand it provides the advantage of being non-invasive, voluntary participants are more likely, and provides a relatable data set for signal analysis. The human hand also allows for 19 degrees of freedom to experiment with as well as lending the fact that the manipulation is fairly easily done. With the aid of instrumented data gloves, this study examines the relationship between the finger and hand motions, how the user interprets those motions, and how the user utilizes those motions to achieve the goal of positioning a 2D cursor within a predefined target provided by an algorithm. The extrapolated signals and data collected from the finger and hand motions will allow a translatable insight to how neural signals may be interpreted.

Cardiovascular Matrix Remodeling: Exploring Cellular Control of Tissue Maintenance and Disease

Authors
Jumana Afaghani, Aaron Armbrister, Amirala Bakhshiannik, Walter Heatherly, Daniela Medina, Jessica Molina, Rachel Montalvan, Michael Orduz, Mohammad Shaver, Mallary Hoidal, Joshua Hutcheson

Major Adviser Joshua Hutcheson



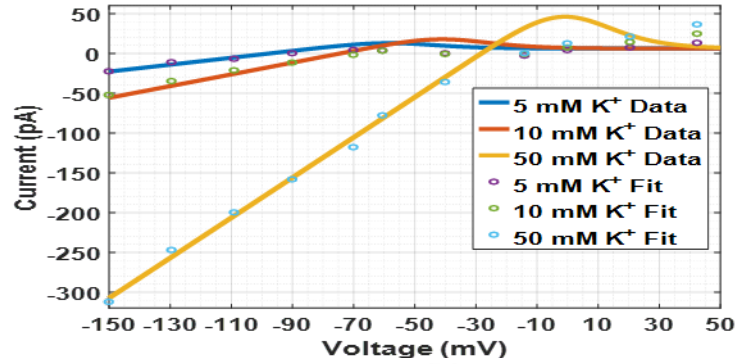
Abstract
Research efforts in the Cardiovascular Matrix Remodeling Laboratory (CMRL) focus on mechanisms through which cardiovascular tissues are built and maintained and the pathological changes that lead to cardiovascular disease—the leading cause of death in Western societies. Our research combines advanced imaging, materials science, biomechanics, and molecular biology to connect cellular processes to tissue function. One major contributor to cardiovascular morbidity is the deposition of calcific mineral and fibrotic collagen within tissues. Cardiovascular tissues rely on a precise structure for appropriate biomechanical performance. Stiffening due to buildup of mineral and collagen diminishes the functional integrity of tissue, leading to complications such as myocardial infarction, stroke, and heart failure. Specifically, we focus on fibrocalcific remodeling in aortic valve disease and atherosclerosis. Our research examines the stimuli (e.g., mechanical stress, inflammation, glucose) that cause cells within cardiovascular tissues to adopt a fibrocalcific response. We then assess the means through which cells transport collagen and mineral from intracellular compartments to the extracellular matrix. Future studies in the CMRL will seek to disrupt these mechanisms to treat cardiovascular fibrocalcific remodeling before irreversible stages. Accomplishing these goals requires an interdisciplinary effort, and researchers in the CMRL work at the interface between bioengineering and molecular biology.

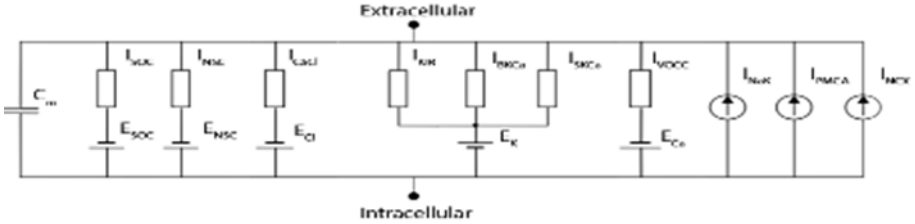
Mathematical Model of Plasma Membrane Electrophysiology in a Single Pericyte Cell

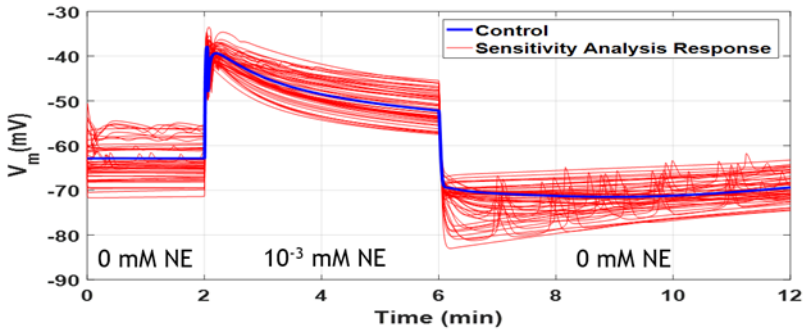
Authors

Asad Mirza, Arash Moshkforoush, Nikolaos Tsoukias

Major Adviser Dr. Nikolaos Tsoukias







Abstract

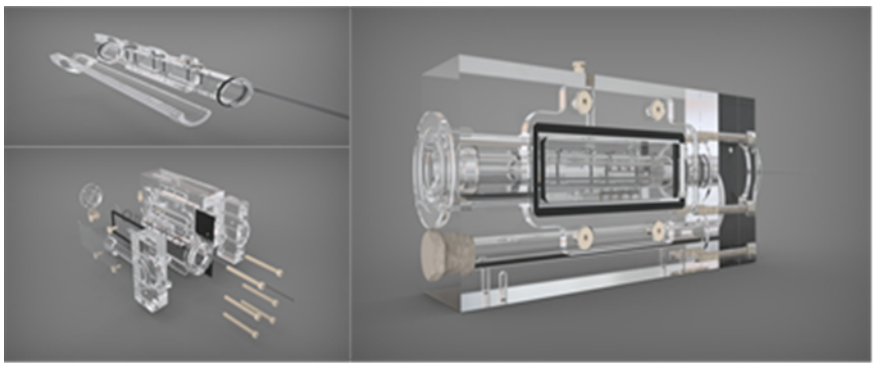
A mathematical model of a single pericyte cell was developed based on data available in literature. The model incorporates the dynamic behavior of 1) plasma membrane currents; 2) release and uptake of Ca^{2+} by the sarcoplasmic reticulum; 3) tracking of cytosolic Ca^{2+}, K^+, Na^+, and Cl^-; and 4) electrophysiological response due to norepinephrine (NE) stimulus. Current and voltage data attained from literature review was fitted to known equations for these channels. Coupled differential equations were then used along with these parameters to show the dynamic change of ion concentrations, membrane voltage, and gating variables. Validation was done using available literature data on NE and K+ stimulation. The proposed model predicted the depolarization and repolarization effects of NE and the increasing depolarization effects of increasing external K+ levels as reported in the literature. Further research for this model will aid in elucidating the underlying role of pericytes on arterial constriction/dilation, vasomotion, and in understanding their roles in disease states.

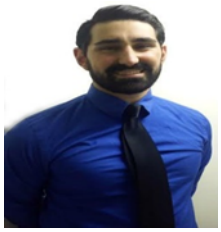
Towards the development of a bioreactor system that mimics the human circulation

Authors

Robin Gomez, Manuel Perez, Alexander Williams, Alejandro Pinero, Omkar Mankame Sharan Ramaswamy

Major Adviser Dr. Sharan Ramaswamy





Abstract

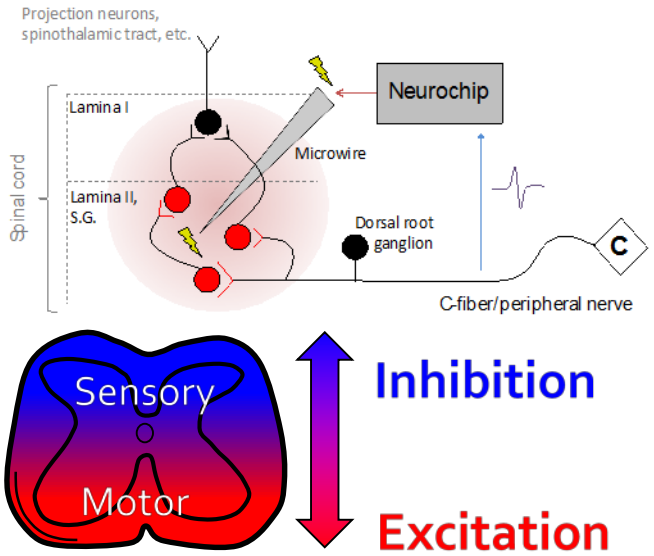
Every year heart disease is responsible for approximately 610,000 deaths in the United States. The strong link between mechanical environments and cardiovascular cell and tissue development is recognized yet, remains understudied. Towards facilitating this process, we have developed and utilized a bioreactor centered on the coupling or decoupling of flow, flexure and stretch mechanical stress states, which are innate to the cardiovascular system. The current bioreactor design in our laboratory houses cardiac tissue samples that can also accommodate physiologically relevant conditions of pulsatile flow. Previous experiments in our laboratory investigated stem cell concomitant differentiation into heterogeneous cell populations resembling the native valve architecture under flex-flow conditions. In addition, experiments showed augmented collagen formation and enhanced DNA when a flow component was present within the local cell/tissue environment. We have in addition recently found preliminary evidence that oscillatory shear stresses (OSS) are potentially responsible for promoting the valvular and more broadly, the cardiovascular phenotype. Specifically our experiments have found that pulsatile flow-alone has the potential to recapitulate favorable gene expression seen earlier via flex-flow conditioning, with OSS being the primary mechanical stimulus that triggered desirable cell signaling events. Thus, in order to fully promote the growth of engineered heart valve tissues as a model system for therapeutic discovery, we now propose to subject tissue samples to physiologically-relevant pulsatile waveforms. The motivation behind this lies with conditioning cell/tissues within a physiological window of OSS rather than using sub or supra-physiological OSS ranges, which we hypothesize, will lead to enhanced biological constructs, based on our findings to-date.

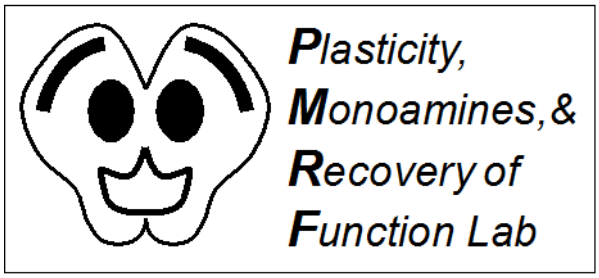
Maladaptive neural plasticity in spinal sensorimotor circuits: a driver of impairment on a road of opportunity

Authors

Valetina Melero and Kelly Nair Rojas (undergraduate researchers); Jacob McPherson (PI)

Major Adviser Jacob McPherson





Abstract

We conduct animal research and human-subjects research in the broad fields of neuro -physiology, -engineering, and -rehabilitation. We are particularly interested in the ways that brainstem-spinal neural circuits integrate sensorimotor information after stroke and spinal cord injury, and how technology can be used to exploit the adaptive capacity of the central nervous system (CNS) to improve therapeutic outcomes.

In one line of research, we use recurrent neural-computer interfaces (rNCI) to study neural plasticity in spinal pain-processing circuits in rodents. rNCI are an emerging technology that uses biophysical signals recorded from one area of the CNS to trigger stimulation in another. In this project, we aim to use rNCI to selectively weaken overactive pain-related neurons by driving neural plasticity.

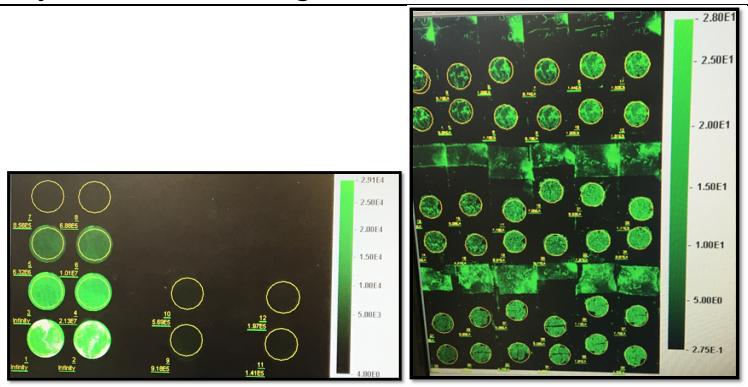
In our other primary line of research, we study the relationship between volitional motor control and pain perception in humans. This work is motivated by the observations that (a) injuries to the CNS frequently result both in motor deficits and changes in pain perception, and that (b) many interventions designed to target motor deficits also impact pain perception (and vice versa). Here, we use mechatronic devices, electromyography, non-invasive stimulation, and neuropharmacology to understand the sensorimotor dynamic in the context of brainstem-spinal neuromodulation.

Image Guided Cancer Therapy: Developing a Process for Quantitative Organ Imaging

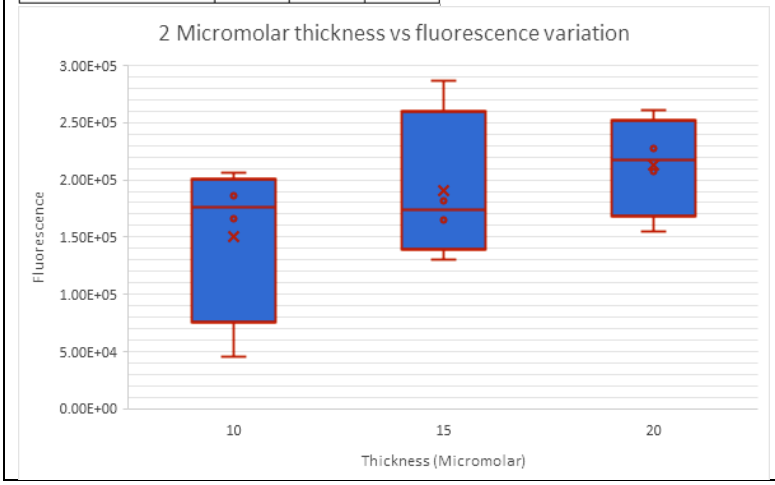
Authors

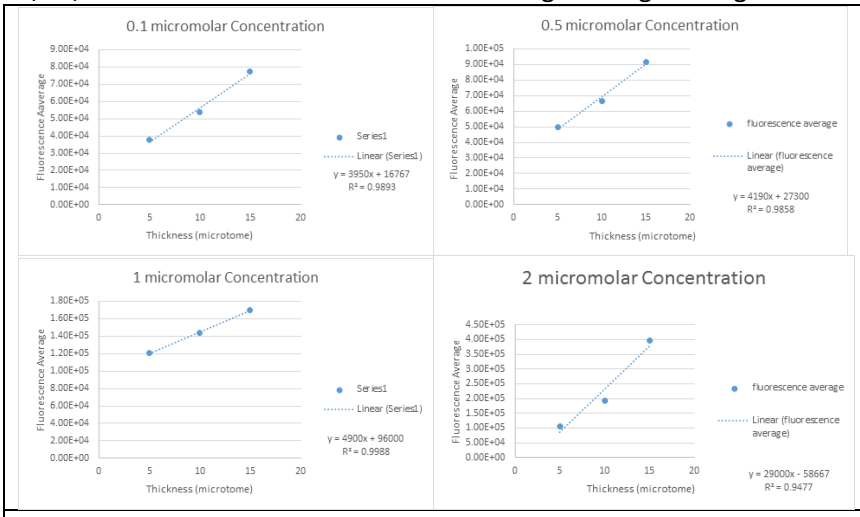
Zoë Bernard, Caroline M Betances, Pedro Da Costa, Juanpablo Olguin

Major Adviser: Ranu Jung



	Thickness (microns)		
Concentration (Micromolar)	5	10	15
0.1	3.77E+04	5.39E+04	7.72E+04
0.5	4.97E+04	6.63E+04	9.16E+04
1	1.21E+05	1.44E+05	1.70E+05
2	1.06E+05	1.92E+05	3.96E+05





Abstract

To develop a protocol to obtain a given amount of fluorescence based on a specified drug concentration. This protocol is based on a calibration curve that will demonstrate quantitatively the concentration of drug based on fluorescence levels at certain tissue depths from nanoparticles loaded with IR-820 dye and drug. This linear relationship would allow for the determination of how much fluorescence is expected given a certain amount of IR-820 during future experiments involving IR-820 conjugated nanoparticles applied in vitro. This was achieved by synthesizing phantoms using sodium chloride, Tris buffer, sodium azide, porcine gelatin and IR-820. Different concentrations of IR-820 (4µM, 2µM, 1µM, 0.5µM, 0.25µM, and a control) were added to the phantoms. Precise and accurate slices of the molds at thicknesses of 5µm, 10µm, 15µm, and 20µm were achieved using a cryostat. Their fluorescence was imaged and measured using an Odyssey CLX. The data from the experiments concluded a clear relationship between the thickness of the gel and the concentration of the IR-820, this includes the assumption of uniform distribution of the nanoparticles throughout the slices.