Mar 6th, 12:00 AM

07. Engineering

Southwestern Oklahoma State University

Testing Coiled Nylon Threads as Artificial Muscles for Exoskeletons

Shawn Ray

Abstract

The popularity of robotic exoskeletons in rehabilitation has recently been on the rise. However, one of the main limitations of these robotic exoskeletons is the large weight that is put onto the user and its bulkiness. Researchers have been looking into creating lightweight artificial muscles to help reduce the weight of robotic exoskeleton systems dedicated to rehabilitation purposes, and thus and better the rehabilitation process for the patients. These artificial muscles are being created by coiling nylon string and applying heat to the coil so that it can produce a contracting force. The proposed project is, first recreate these artificial muscles, and second characterize their behavior. Our study shows that it is possible to create artificial muscles by coiling nylon string, and that these muscles contract when heated. For future applications, the artificial muscles will be made using conductive nylon to use electrical stimuli instead of an external heat source to produce a contraction force.

Perceptual Optimization of Fast Magnetic Resonance Imaging Techniques

Yuhao Jiang

Abstract

Magnetic Resonance Imaging (MRI) is a fast developing image modality. The major drawback of MRI is the long acquisition time. Fast imaging can improve MR imaging by reducing motion effects that adversely impact clinical usage, by providing new information, and by increasing patient throughput. Developing a new method in fast MR imaging is both time consuming and expensive. Also, it comes at the expense of image quality. Human perception model, which includes human visual system properties, can provide quantitative values for the assessment of image quality. A new MR dedicated human observer model was developed by incorporating the analysis and physiological and psychophysical concepts. Phantom and simulated images was created to test the model. We applied this model to quantitatively guide the development and optimization of fast MRI methods.

In Vivo Evaluation of Novel PEGDA-PCL Scaffold for Cartilage Generation

Helga Progri

Abstract

Our long-term goal is to develop a functional scaffold that can be used on multiple tissue types and maintain functionality under load-bearing conditions in the human body. Our lab has developed a PEGDA-based composite scaffold, by sandwiching PEGDA in between PCL nanofibers, thereby creating a PCL-PEGDA scaffold. Our goal is to determine whether the scaffold improves the rate of cartilage formation and establish a protocol for histology to examine the amount of cartilage formation. Animal studies were performed at OUHSC. Each rat got two of either PEGDA or PCL-PEGDA. Rats were returned to normal cage activity and euthanized after 28 days of implantation. Samples were fixed, embedded within the acrylic resin, and sections were cut using a rotatory manual microtome. Sections were stained with Safranin-O and with H&E or picrosirius red and imaged by bright-field or polarized light microscopy. Histology examinations revealed progressive tissue formation with distinct morphological differences in tissue formation in regions around the grafts. Higher amount of disc height was found at PCL-PEGDA compared to only PEGDA scaffolds. This study advances orthopedic cement research by providing the understanding of how the electrospun fiber anchored PEGDA is affected at in vivo conditions. This novel PCL-PEGDA would provide an environment required for enhancing tissue integration with native tissue that produces better clinical outcomes for cartilage repair or regeneration.

Quantifying Effective Viscosity of Microswimmer Suspensions

Marion Mantia, Mel Vaughan, & Gang Xu

Abstract

The flagellum is a microscopic hair-like structure that allows cells to move. These motile cells produce a force on the fluid surrounding them and cause mixing as a result of this flagellar motion, which is very influential to material transport, or bio-mixing, at a cellular scale. Since there are a variety of beating patterns which are created through relative doublet sliding as a result of the motion of the radial spokes, this mixing is often difficult to understand. Therefore, to quantify the effects of active micro-swimmers on the rheological properties of the medium, the effective viscosity of flagella-powered microalga suspensions will be measured. The unicellular bi-flagellated green microalga Chlamydomonas Reinhardtii was used, because they can model the microalga used in biofuels as well as human cells. The effective viscosity of active suspensions was measured with various cell volume fractions at different shear rates using a cone-and plate viscometer. These measurements can determine the effect of the motile cell has on the rheology of the suspension, and, consequently, the suspension's ability to transfer material, or bio-mix. The results of this project will lead to a greater understanding of how the mixing of active particles directly influences biofuels. This research will also broaden our understanding of how to utilize the effects of the flagellum to direct material transport, which could be used for the advancement of disease treatment.

Smart Medical System for Analysis in Cardiopulmonary Resuscitation (CPR) Quality.

Erin Drewke & Mai Pham

Abstract

Cardiac arrest occurs in 2-6% of children admitted to Pediatric Intensive Care Units, where severe hypoxia and respiratory failure are the most common causes. Accurate, non-invasive, and real-time monitoring of oxygenation and circulation is paramount to improving Cardiopulmonary Resuscitation (CPR) outcomes. To address this, the Smart Medical System will interface three types of monitoring technology crucial for assessing resuscitation efforts: Near-Infrared Spectroscopy (NIRS), Volumetric Capnography (VCap), and Arterial Line sensing, to analyze and communicate CPR procedures as stated in the American Heart Association Pediatric Advanced Life Support (AHA PALS) procedure. Simulink and C-Code from MATLAB will receive data and automate the PALS procedure. Inputs will be readings from the monitors. Outputs will be conclusions after data processes through parameters. An electrical circuit with XOR digital logic will send HIGH outputs to HDMI pins 13/18 for Sink-Source status changes. This will display or embed necessary screens and messages to the physician to optimize CPR. The following non-invasive values may extensively assist in the assessment of CPR: rSO2 from NIRS for circulation of oxygen; EtCO2 from VCap for CO2 elimination in the lungs; Heart Rate (HR) and Blood Pressure (BR) from Arterial Line sensing for pulse presence. The Smart Medical System will need a shield to protect interface connections from defibrillation impacts as shock is used in the PALS procedure.

Electrical Mechanism for a Digital Light Processing 3D Printer

Eileen Hernandez & Mohammad Hossan

Abstract

The digital light processing (DLP) is recently used in 3D printing of parts for faster speed, greater details and better surface finish. Digital Light Processing 3D printer is capable of curing photosensitive resin with the use of a UV light source reflected on specific areas to form a specific 3D shape out from the resin bath. This poster presents the design and performance evaluation of an electrical control unit for a DLP 3D printer. The control unit consists of various components including sensors, microcontrollers, motors, and switches. A raspberry Pi 3, a microcontroller, was programmed to control NanoDLP, an open source platform for slicing and image processing, as well as mechanical actuation system. The developed control unit was tested and optimized to synchronize the exporting and slicing of 3D STL files of parts into a projector and monitor process parameters such as temperature of the unit, exposure time, z-axis range and emergency shut off. The test demonstration shows that the developed control unit can successfully perform the specified job with accuracy and precision. Therefore, the developed electrical control unit can be used to command a DLP printer to work under user defined conditions. It also provides a least expensive alternative to the currently available electrical control unit for DLP printers.

Design and Fabrication of Mechanical Actuation Mechanism for CLIP Printers

Mohammad Hossan& Connor Self

Abstract

Continuous liquid interface production (CLIP) has recently revolutionized the additive manufacturing technology with faster processing time, maintaining excellent isotropic properties and superior surface quality of the finished product. However functionality and process optimization of the CLIP printer heavily depends on the accuracy and precision of the mechanical actuation system. Mechanical actuation system coordinates and ensures optical requirement, curing time and processing speed of the CLIP printer. This project examines the design and manufacture of a low cost but highly efficient mechanical actuation system. Actuation system was initially designed and optimized with 3D modeling using AutoCAD, a computer aided design (CAD) software. The designed system consists of stepper motor mounted in a lead screw to provide a linear slide for the platform, flexible resin container, digital light projection (DLP) projector holder and an adjustable build platform. The individual parts in AutoCAD modeling were converted into STL file/G-codes and printed using an ObjetPro 30 3D printer. The actuation system was then assembled with the in-house manufactured parts and tested. The developed system was able to produce linear motion with at demand and variable speeds without mechanical noise and vibration. The developed actuation system will provide more flexibility and reduce the cost of CLIP printer.

Power Quality Measurement System

Michael Martin & Kevin Ghale

Abstract

Power quality is a theoretical measurement of the efficiency of the power, in voltage and current, that a system's components are receiving compared to optimal supply. A system experiencing "poor" power quality can cause components to fail leading to system downtime, economic failure, and overall machine failure. Placed between the power source and the machine unit, the proposed Power Quality Measurement device will utilize live data-acquisition to measure the harmonic distortion and other power qualities flowing from HVAC units back to the supply source. Variable frequency drives and other high-speed switching devices utilized in an Air Handling Unit (AHU) are prone to sending harmonic distortion back down the supply line toward the transmission station, which results in users being penalized by electrical companies. The device could also be utilized for predictive maintenance purposes to notify technicians when motors or other components are requiring maintenance before causing system failure. The device will be an embedded circuit system including an evaluation board equipped with current and voltage inputs for reading 3-phase-480 volt systems, and a communications system(micro-controller) that will transmit the power quality data to a SMART device via an IoT controller over a serial communication. The communication stack will relay data to a user interface for company technicians for easy monitoring.

Attachment of fibronectin with titanium by tresyl chloride activation method: chemical and cell analysis

Dhakshyane Tamil Arasu

Abstract

Basic terminal hydroxyl groups of a pure titanium surface react with tresyl chloride, which allows for further coupling with fibronectin. Previous in vivo studies using a rabbit femur model found that immobilizing fibronectin onto cylindrical pure titanium implants enhanced bone regeneration around implants. However, pure titanium has limited applications in the biomedical industry due to its inferior mechanical and biological properties, compared to biomedical grade titanium alloys, such as Ti-6Al-4V (the most commonly used titanium alloy in medical devices). To date, no study has evaluated the attachment of fibronectin on Ti-6Al-4V (referred simply as Ti) by the tresyl chloride activation method. Thus, we examined whether human plasma FN can be attached to Ti-6Al-4V via the tresyl chloride activation method and evaluate the effect of the attachment on osteoblast cell adhesion and proliferation

Mobile Radiation Shielding for SWOSU Radiologic Technology Program

Jacob Gonzalez, Cindi Albrightson, Ezgi Gursel, & Brooks Pond

Abstract

Senior capstone students in the Engineering Technology program at SWOSU-Weatherford were tasked with building mobile radiation shields that will allow students in the Radiologic Technology program at SWOSU-Sayre to be protected from scatter radiation during x-ray lab sessions. The students will present their research, design and preliminary sketches for Oklahoma Research Day. The students hope to have all the panels complete and ready to move in to the Radiologic Technology program's new location on the Weatherford campus.

Degradation and Biocompatibility Analysis of a photo-Polymer for DLP Printers

Carlos Palou

Abstract

Digital light processing (DLP) based 3D printers have become popular for higher surface quality and faster processing. However, Printing materials that can be used for biomedical devices in a living body are limited. This poster presents degradation and biocompatibility analysis for Cyanate Ester, a candidate flexible resin material. For degradation experiment, thin circular plates of Cyanate Ester (approximately 1 cm diameter) was cured under UV light exposure and submerged in PBS buffer with pH of 7.5. Plates were weighted before submerging in PBS and then for 2, 4 and 8 weeks. Human dermal fibroblasts cells were cultured with cured cyanate ester plate. Cell performance and interactions with Cyanate Ester plate were evaluated by quantifying various cellular functions such as proliferation, differentiation, and adhesion. Results show that degradation rate is much slower than common biomaterial such as Polyethylene glycol diacrylate (PEGDA) hydrogel. Slower degradation rate may be helpful for certain biomedical application such as bioresorbable stent for cardiovascular diseases. On the other hand, biocompatibility studies show that cell performance in Cyanate Ester was reduced compared to a control group without Cyanate Ester plate. However, more studies are being conducted to verify this finding with other cell lines such as osteoblast cells. These studies can help to expand the applications of DLP 3D printers, especially for biomedical applications.

Design, fabrication and testing of a continuous liquid interface production system

Carlos Palou

Abstract

Continuous Liquid Interface Production (CLIP) has recently emerged as an effective additive manufacturing technology with faster printing speed and superior surface finish. This poster presents in-house design and development of a CLIP system for printing flow diverters. UV light source from a digital light processing (DLP) computer projector was used to initiate polymerization in a vat of liquid photocurable resin-Cynante Ester. A “dead-zone” was created at the surface of the container by creating oxygen-permeable membrane between the container and the resin. It prevents the polymer from curing on the container itself. Mechanical actuation system based on a stepper motor and lead screw was designed in 3D computer modeling and fabricated in UCO mechanical shop. Electrical control unit consists of Raspberry Pi microcontroller, rely switch and various sensors which was designed to project the sliced the computer aided design (CAD) file with NanoDLP. Finally, the assembled CLIP system was tested to print sample cylinders of different sizes. The final goal for the prototype will be to produce parts with sub-millimeter precision. The developed CLIP system will be used to design and fabricate medical grade flow diverters.

HVAC Air Filter Test and Air Behavior Analysis

Natalie Nguyen

Abstract

The effectiveness of an air filter can be quantified by its MERV (minimum efficiency reporting value) rating. The higher the MERV rating, the better the filter is at purifying particles from the air. The MERV rating can be determined by measuring the particle size efficiency, which is the fraction of particles that are captured by an air filter for a given diameter. The purpose of this project is to construct a scale model of HVAC air filter test bench that is compliant with the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 52.2 and the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) 680. This test bench is used to measure the particle size efficiency. To complete this project, modeling was completed using proprietary software. Calculations were also performed to predict the fluid flow behavior in the air duct. These calculations were based on holding the face velocity of the duct constant between the full-scale model and the scaled down prototype. Computational fluid dynamics (CFD) simulations will also be completed in the future in order to verify the theoretical calculations. The results of the final calculations showed that the total pressure loss through the system to be 7.468 inches of water column and 8.896 inches of water column in the prototype and full-scale model, respectively.

Computational Modeling of the Inner Ear using COMSOL Multiphysics

Scott Mattison & Natalie Nguyen

Abstract

The Center for Hearing and Communication estimates that 48 million Americans suffer from hearing loss. Utilizing finite element analysis and finite difference time domain methods we hope to develop an accurate model of the mechanical and electrical responses of the inner ear to sound stimulation. Developing an accurate simulation of the inner ear's response to sound will enable us to improve long-term outcomes in patients with hearing loss through the development of improved algorithms for existing intervention techniques and provide a powerful platform for evaluating interventions for hearing loss. To accomplish this goal, we have identified published datasets of the mechanical motion of the inner ear in response to pure tone audio signals at various frequencies and decibel levels. Using these initial datasets and anatomical scans of the inner ear, we have begun developing initial models of the motion of the inner ear using COMSOL Multiphysics. COMSOL Multiphysics is a commercially available software that has powerful toolboxes for simulating the complex interactions of fluid motion, tissue motion, and electrical responses that form the inner ear's response to sound. To date, we have developed an initial model of a simplified cochlea in COMSOL that will form the framework for our future work.

Design, Development, and Analysis of Bioresorbable Flow Diverters for Biomedical Applications

Zackary Maggard & Mohammad Hossan

Abstract

Flow diverters (FDs) use fine-meshed tubes to divert blood flow away from the aneurysmal cavity to cure aneurysm and remodel the blood vessel network. However, current FDs are created from woven metal wire and can fail by migration, malposition, or restenosis. This poster presents the design, fabrication, and characterization of a novel bioresorbable fine-meshed FDs based on Polylactic acid (PLA). FDs were designed in 3D computer modeling with SolidWorks. The model was then converted to laser machine-readable code to fabricate control nitinol FDs using a commercial laser machine while PLA FDs were fabricated in fused deposition modeling (FDM). Heat treatment of PLA FDs was conducted to improve mechanical flexibility. Mechanical characterization was conducted by a universal testing machine to evaluate tensile, radial compression and bending profile of both control and PLA FDs. The results show that the mechanical properties of PLA FDs are comparable to the control nitinol FDs. A silicon aneurysm model is being developed using lost wax casting method to study flow characteristics using particle image velocimetry (PIV). The effect of pore sizes, location, size, and orientation of aneurysm cavity on flow patterns and flow-induced parameters such as wall shear stress will be studied. This study will help to develop bioresorbable FDs for aneurysm treatment.

Vertical Michelson-Morley Interferometer

Shynette Porter

Abstract

In our project, we will be discussing the results of the Michelson-Morley-Interferometer experiment in both the horizontal and vertical direction in the Earth's gravitational field. It will be shown if there are any effects of ether, a medium to be thought the cause of propagation of light in air. Our goal would be to visually obtain the data of the continuous fringe movement due to the relative movement of the interferometer, on a screen with a camera. The ending or gradual stop of the continuous fringes during the rotation in the X and Y Axis will lead to a proper explanation of the phenomenon resulting for such results, which we would be observing through this experiment. Our presentation will contain some extensive background information, a proper justification of our model which will be beneficial for both the economic aspect and accuracy of the experiment, and we would show a proper guideline and justification to get the required results that we intend to see.

Detmerminig the Mechanical properties of Fibroblast-Populated Collagen Lattices

Mel Vaughan, Gang Xu, & Joseph Wagner

Abstract

Fibroblast-populated collagen lattices (FPCL) are commonly used as dermal or skin tissue equivalents in order to study the mechanobiological mechanisms behind fibrosis action. This fibrous action playing a role in wound healing and cancer development. More partially these studies develop novel diagnosis for dupuytren's contracture, which is caused by an in increase in biomechanical forces and stiffness of the tissue. This change in fibroblast can create such a great tension that it prevents your fingers from extending. Whereas the only cure for Dupuytren's disease is an invasive surgery with a low success rate or even amputation. Previously these biomechanical properties of FPCL's were determined with a variety of analytical methods. The first method of measuring the tension is to measure the height of the FPCL. The second method is to release these FPCL from the bottom of the dish they are attached to. These methods are great way to compare the effects of two different treatment methods on the FPCL. However, this analysis is analytical rather than numerical and does determine if the FPCL samples being compared have the same biomechanical properties before treatment. In order to determine the biomechanical stiffness of the FBPL an indention method will be used. This measurement process of indentation can be performed with expensive machinery is or a complicated indentation process that could potentially damage the tissue. However, these processes are near impossible for

2019 CU Engineering and Applied Mathematics Summer Academy

Dalton Whitehead

Abstract

In the summer of 2019, the Chemistry, Physics, and Engineering department at CU hosted an academy geared towards engineering to help provide High School students an introduction to STEM concepts and provide a hands-on experience. The academy brought 20 High School students, 4 High School Jr. Counselors who participated in the academy in prior years and help guide the new campers providing them with a valuable leadership experience, 4 Counselors who were College students, Dr. Sheila Youngblood who was the Academy Director, and 2 Teachers who are Kyle Holman and Zach Morrison. The summer academy theme was aerospace engineering, where the campers were challenged to design and create a functioning hovercraft while using the engineering design process and over the course of 1 week. Many activities were mixed into the lessons in order to optimize the hands-on experience and add in a bunch of fun!

Histomorphotmetric Analysis Of Skin, Cartilage And Bone Tissue

Priyanka Rao

Abstract

Histomorphometric analysis is the histologic sectioning of normal and diseased samples, such as healing wounds and fractures, which is known to be widely used in research. However, over previous decades, certain techniques and analysis have not been recognized in a long time causing them to lack in solutions that they are looking for. Therefore, the results have recently become more feasible with the development of digital whole slide imaging and computerized image analysis systems that can interact with digital slides. This technique is used for various applications mainly skin, cartilage and bone respectively. One of the aims of this project is to develop a skin graft model that can mimic the structure and function of the dermis by using Electrospun Nano fiber coating to depict collagen, polyethylene Glycol Diacrylate(PEGDA) and poly e-caprolactone (PCL) scaffolds which were cultured using rat dermal fibroblast cells. By depicting with these materials, the results show that histomorphometric evaluation quanitifies the shape, size and number of cells present as well as other morphological operations. This technique also displays various features within the cartilage respectively. Furthermore, the similar analysis will be applied on the bone where electro spun nanofiber coating techniques were used to improve the mechanical and biological functions of titanium implant.

Probing Tension Generation in the Portable Engineered Dermal-Equivalent Tissue

Erin Drewke, Gang Xu, Abasi-ama Udeme, & Mel Vaughan

Abstract

The purpose of this study is to probe and quantify the mechanical tension generated in the fibroblast-populated collagen lattices treated with a growth factor. In this study, we created tension-maintaining dermal equivalents by co-culturing human dermal fibroblasts with type-I collagens with the addition of transformative growth factor Beta.

Polymerized collagen lattices were supported structurally by plastic mesh rings. TGF-Beta was added to half of the lattices to study its effects on tension generation. The cultures were incubated in a CO2 incubator for 7 days to allow the lattices to develop. After incubation, the generated mechanical tension in these dermal equivalents was probed by removing a small circular section (2-mm in diameter) from the tissue with a biopsy punch. The expansions of these induced wounds were recorded and measured at various time points. The induced wounds in TGF-Beta treated lattices showed quicker and larger expansion than the control, which indicates that the fibroblasts had more tension generated in the presence of TGF-Beta.

Peer Mentor

Support Systems for First Year Engineering Students

Dalton Whitehead

Abstract

An engineering program in southwest Oklahoma is growing exponentially and the department needs to capitalize on that growth in order to sustain it. In Oklahoma there is an expected 15.4% growth in architecture and engineering careers from 2008 to 2018 according to The Oklahoma Employment Security Commission, Economic Research and Analysis Division [1]. Regional university engineering programs serve as pipeline programs for students in rural areas to attain degrees and secure job placement in the growing STEM career opportunities in Oklahoma. This university's engineering program offers five engineering disciplines for an AAS in Engineering: Mechanical, Industrial, Electrical, Civil and Environmental. This program began in 2014 and has had 24 graduates to date. The program's ability to retain students past the first year is essential. The course load is heavy with approximately 18 hours per semester expected for a student to stay on track in the program. The Engineering Program utilizes peer support systems in the first year engineering program. First year engineering students experience ENGR 1411 (Introduction to Engineering) and ENGR 2113(Statics). The development of the Engineering Learning Laboratory for Statics allows upperclassmen to mentor and support first year engineering students.

Peer Mentor Support Systems for First Year Engineering Students

Victoria Due

Abstract

An engineering program in southwest Oklahoma is growing exponentially and the department needs to capitalize on that growth in order to sustain it. In Oklahoma there is an expected 15.4% growth in architecture and engineering careers from 2008 to 2018 according to The Oklahoma Employment Security Commission, Economic Research and Analysis Division [1]. Regional university engineering programs serve as pipeline programs for students in rural areas to attain degrees and secure job placement in the growing STEM career opportunities in Oklahoma. This university's engineering program offers five engineering disciplines for an AAS in Engineering: Mechanical, Industrial, Electrical, Civil and Environmental. This program began in 2014 and has had 24 graduates to date. The program's ability to retain students past the first year is essential. The course load is heavy with approximately 18 hours per semester expected for a student to stay on track in the program. The Engineering Program utilizes peer mentor support systems in the first year engineering program. First year engineering students experience ENGR 1411 (Introduction to Engineering) and ENGR 2113(Statics). The development of the Engineering Learning Laboratory for Statics allows upperclassmen to mentor and support first year engineering students.

Light-Weight Walker Frame for Elderly and Injured People

Sabin Kapali

Abstract

More than 1.5 million people in the United States alone, use walker frames to improve their mobility. Unfortunately, despite its clinical success with older adults and patients with various chronic conditions, the walker may, in certain situations, interfere with one's ability to maintain balance, leading to severe fall-related injuries and pain. Furthermore, repetitive stresses on the upper-extremity joints owing to extended or improper use of the walker, may increase the risk for tendonitis, osteoarthritis, and carpal tunnel syndrome. More particularly, patients with arthritis, are at high risk of developing joint inflammation. Studies showed that 30% to 50% of people abandon using the walker soon after receiving it, mostly because it was "difficult and/or risky to use". All-inclusive, the search for a lightweight walker frame that can simultaneously ease patient mobility without the risk of injury and joint pain is still on the lookout, and the design features proposed in the current project may be a better alternative.

Development and Visualization of Nonhomogenous Tension Generation in Engineered Tissue

Anna McCoy, Gang Xu, & Mel Vaughan

Abstract

Fibroblasts are cells in connective tissue which produce and reorganize the extracellular collagen matrix. The fibroblast-populated collagen lattices have been a common tissue model for studying would healing, fibrosis and cancer progression. The goal for this research project is to engineer and characterize a special type of collagen lattices. The mechanical tension and reorganization created by the fibroblast would develop primarily in the lower half of the anchored lattices. The approach was to measure the reorganization and compaction of the collagen matrix by optical coherence tomography (OCT) every day. In addition, tension generation was probed by releasing the collagen matrix from the attachment with the substrate and measuring ensuring contraction. Our preliminary results showed that mechanical and morphological changes of developing tissue depend strongly on the initial distribution of cells. Studying the biomechanics of simple tissue models will be an important step in understanding the normal and pathological development of native tissues.

Evaluate the Effect of Electric Field on Osteoblast Cells

Naveen Thirunilath & Mohammad Hossan

Abstract

Electric filed is one of the major actuation mechanism in microfluidic devices for cell manipulations and cellular analysis. However the impact of electric field on cells and their cellular functions or the safe range of electric field for various microfluidic applications are not established yet. The goal of this project is to analyze the impact of electric field on osteoblasts cells and suggest a safe range of electric field for electric field guided manipulation of cells. Common microchannel designs from literature such as sharp and smooth constriction region, convergent-divergent region, serpentine regions, obstacles of circular, rectangular and diamond shape in the channels were fabricated using standard photolithography techniques. The microchannels were filled with mouse osteoblast cells and the DC electric potentials of different magnitude and time were applied. After the exposure of electricity, the cells are collected from the chamber and counted the live and dead cells using cytometer. The live cells were then cultured back and staining after 48 hours to evaluate proliferation and differentiation. The results show that exposure time and channel design does have negative impact on the cell functions even with otherwise safe electric field limit. In general, up to 300 V in a typical microchannel does not have adverse effect on cells. This study will help to better design of microfluidic devices for cell manipulation without compromising their cellular performance.

Automated Adjustable Temperature Mattress

Craighton Hale

Abstract

We set out to design a mattress that will cool and heat the user by creating a mattress that would have these systems built in. Sleep temperature is a leading factor in sleep quality. We want to solve this issue and offer a higher quality of sleep by adjusting the temperature of the mattress.

In order to design a mattress capable of adjusting the temperature of itself we have divided the project into three sections; Mattress Heater System (MHS), Mattress Cooling System (MCS), and Temperature Control System (TCS). The MHS will be a combination of mechanical and electrical systems which will heat a wire to a desired temperature. The MCS will be a combination of mechanical and electrical systems which will deliver airflow through a grid of pipes that will lay within the mattress. The MCS will be divided into two further sections; Air Delivery (MCS/AD) and Air Cooling (MCS/AC). The TCS will be the controller which will incorporate an MCU, sensors, and user inputs in order to produce the desired result for the user.

There are a few competitors in the field of adjustable temperature mattresses, of which seem to offer the same style of heating and cooling; hydro-based water circulation. We aim to offer the same heating and cooling options; however, we will be using different approaches. What we hope to improve on is the ability to offer air flow, make it less expensive, and reduce the need for regular maintenance.

Finite Element Analysis of a Blast Induced Head Injury

Mohammad Hossan & Rahul Sridhar

Abstract

Traumatic brain injury is one of the common injuries in US for football players, military personnel and road accident survivors. The aim of the research is to study the response of cerebral fluids and how the blast wave propagates when a sudden impact happens. A finite element model of the brain injury has been prepared and will be tested under various conditions using ANSYS and LS Dyna. Initial design was developed with a closed cylinder hit by a foreign object. Material properties were defined based on the bone, tissue properties from literature. The impact velocity is set to be 10m/s which is typically a real-life scenario and has been also verified with previous models. The simulation provides the pressure changes in the different segment of the brain and location of stress concentrations. Currently a more rigorous model is being developed based on Human brain with the skull images from MRI and CT scans. This rigorous model will help to better understand blast induced cavitation formation and related injuries.

Microwave Imaging System

Nathaniel Ashley & Kyle Espinosa

Abstract

Microwave Imaging System

In the field of diagnostic medicine, there are many methods to visualize disease pathology in the body. The prevalent method of medical imaging techniques relies on ionizing radiation, which is harmful to patients on a cellular level. As more imaging tests are performed, safer alternatives must be developed to protect the public from these harmful effects. The design of a Microwave Imaging (MWI) system is a novel solution that will produce images while keeping the patient safe from harmful radiation. Lower frequency microwaves are not as harmful to DNA and cellular structures. As a result, a low-powered MWI system would be a safer method to acquire diagnostic medical images. Although this technology has been actively researched for several decades, the proposed system design differs in that it will attempt to merge the circular data collection patterns of computed tomography and magnetic resonance imaging with the backscattered signal processing of radar and ultrasound. Consequently, the system would be able to produce three-dimensional diagnostic medical images by safer means than currently used conventional imaging methods.

Rocketry: Taking The SWOSU Physics Club to New Heights

Daniel Gassen, Wayne Trail, & Cameron Cinnamon

Abstract

Since 2017, the Kloudbusters Rocketry Club in Argonia, Kansas has put on a rocketry competition open to Colleges and Universities. The goal is to fly a rocket to a minimum of 8000 feet and safely return the rocket to the ground, and its payload, a golf ball, to a specified location near the launch site. In order to reach 8000 feet, competition rockets need to reach speeds near or above the speed of sound, 770 miles per hour, within about two seconds after launch. The stresses and forces to reach these speeds make precision in design and construction critical. We are aided in the design phase by an open source program called Open Rocket, which allows us to simulate flights with various rockets and engines. In-flight parameters like velocity, acceleration, altitude, orientation, and GPS location are handled by on-board microcontrollers we have either purchased, or designed, built, and programmed. The design and testing of the payload delivery system is also challenging. We have multiple ideas for payload delivery including a drone, glider, a parasail, and controlled fall capsule.

Building and Programming an Arduino Based Quadcopter

Daniel Gassen

Abstract

We have designed and built a quad-copter drone with an Arduino microcontroller as the flight-controller. For various projects the SWOSU Physics Club has needed a drone for aerial photography and other purposes. Rather than purchase one, we decided to build one based on the designs and software of Joop Brokking. Our first attempt is a self-leveling drone that weighs about 2.7 lbs. (including the battery), is about 24 inches on a side and stands 10 inches tall. The next phase of the project is to incorporate GPS and video that transmits to the ground.

Electronic Aspirin : Could it Potentially Become a Permanent Solution for Migraine?

Lisa Boye & Alzahra Alshabrakah

Abstract

According to Energies Market Research, migraine is the third prevalent neurological illness affecting approximately 39 million people in the U.S, and one billion people across the globe, which led to the innovation of the Electronic Aspirin, a faster and more effective way to relief migraine. In their poster presentation, Alzahra Alshabrakah from Saudi Arabia and Lisa R. Boye from Liberia will explain what the Electronic Aspirin is, how beneficial it can be for patients who suffer from migraine, and how It differs from other over the counter medications such as regular Aspirin.

Heating Cooling and Air Conditioning(HVAC) Machine Learning Prognosis Tool

Josiah Lok Teck Tie & Sharveen Rajaindran

Abstract

The project that we chose to carry out is the HVAC machine learning prognosis tool. Our main goal in the project is to research and create machine learning algorithms to be able to detect the error that is occurring with the geothermal HVAC unit and to determine a way to predict failure in the system before it occurs. The problem that we are trying to solve is the issue of failures in the HVAC unit which can be caused by many different issues. Solving this issue enables a lot of money to be saved and the shelf life of the unit to be extended. Besides that, it is also reduces man power and saves time as no technician will be needed to go to the area of interest and try to figure out what the issue is. Our plan to solve this issue is by carrying out data analysis, and coming up with a machine learning algorithm that will be able to read the real time data of the HVAC unit and is able to predict potential failure before it occurs so that the necessary precautionary measures can be taken. This solution is much beneficial than any other ones because it is cheaper and faster for the user to detect potential failure. We have to date successfully managed to design an algorithm that can accurately predict the outcomes through regression analysis and are currently working on creating a classification model and are currently trying to piece them together so that we can upload them to the cloud.

A Novel Method in Testing Gyroscopes Used in the E-4B

Phu Dang

Abstract

Gyroscopes are widely implemented in aerospace applications. Due to the law of conservation of momentum, gyroscopes serve as a reference point in three-dimensional space. Gyroscopes are required to be tested at regular intervals for airworthiness. Currently, Boeing's E-4B Systems Integration Lab (SIL) test their gyroscopes by rotating the gyroscope manually. A rotating gyroscope will produce a pickoff signal that can be measured by an oscilloscope. Due to the current testing procedure which requires extensive human intervention, Boeing requested a development of a new method for testing their gyroscopes. Currently, our solution consists of a belt and a pulley system that is driven by a NEMA 23 motor. The motor will be controlled by a Raspberry Pi, and the user will input appropriate commands through a touch screen. We believe that by creating an automated apparatus, human errors could substantially be reduced compared to the current procedure. We have successfully modeled our apparatus in SolidWorks; several components are being constructed using available 3-D printer technology. We have implemented a rotary encoder to relay information such as rotational rate and angle of rotation. Future work includes assembly of the apparatus to be a cohesive unit and begin testing gyroscopes.

Quantifying the Mechanical Motion of the Inner Ear using Optical Coherence Vibrometry

Scott Mattison

Abstract

The cochlea is a small, snail shell like, part of the inner ear responsible for the transduction of mechanical sound pressure into electrical stimulation in the brain. Despite the importance of the cochlea for normal hearing, the mechanical interactions between various components is not well understood. By utilizing a technique known as optical coherence vibrometry we hope to quantify the changes in mechanical motion of the embryonic avian cochlear duct. By observing changes in the response of the cochlea as key regions of the cochlea develop we hope to determine the role each of these components play in healthy hearing. To quantify the mechanical motion of the cochlea we expose the cochlea to pure tone auditory stimuli at various sound pressure levels and frequency. We record the amplitude and phase of the mechanical response key structures in the cochlea and compare them across developmental stages.