Jan 1st, 12:00 AM

08. Engineering

University of Central Oklahoma

Abstracts from the 2014 Oklahoma Research Day

Held at the University of Central Oklahoma

05. Mathematics and Science

08. Engineering

05.08.01 Aerial K9 UAV System

Nick, Rymer

Southwestern Oklahoma State University

First Responders need a reliable tool for use in assessing disaster areas and to assure the safety of personnel and equipment during operations. A UAV (Unmanned Autonomous Vehicle) surveillance system that is easy to operate and that can serve as their eyes and ears for improved situational awareness is the aim of this Aerial K9 project. The initial investigation will consist of evaluating a number of low cost sensor suites in order to obtain an understanding of the behaviors of the UAV when using autonomous programs. This sensor suite will include several sensors e.g. sonar, infrared, laser, etc. and be used to develop algorithms that can be used as a failsafe for fault tolerance. Utilizing an open sourced program called OpenCV (open source computer vision) and a camera together we propose to develop an object detection system. OpenCV is software that's developed to detect objects, faces, 3D map objects, and detect movements, just to name a few of its capabilities. Object recognition will be the basis for object avoidance and facial recognition that could be used as a safety feature to prevent unsafe flying near people.

05.08.02 Interaction and Dynamics of Bipolar Janus Particles in a Background Electric Field

Mohammad, Hossan , Matthew Benton

University of Central Oklahoma

Janus particles, named after ancient Roman god Janus, with two region of different physiochemical properties such as surface charge polarity demonstrate a multitude of interesting effect in a background electric field relevant to many engineering applications. In this research, we implement a robust in-house hybrid numerical scheme to study particle-particle interactions and dynamics for ellipsoidal bipolar Janus particles with and without an external electric field. An immersed interface method is employed to obtain the electric field in a fluid media with embedded bipolar particles and an immersed boundary method is used to predict hydrodynamic response. The bipolarity is imposed by providing surface charges of opposite polarity at the two ends of particles. We investigated the relation between electric field distribution, field-induced force, and particle configurations on assembly/disaggregation. The simulation results show that the particles always undergo electro-orientation process in order to align with the external electric field. The speed of this orientation process depends on the initial particle configurations, direction and strength of the background electric field. The results also show that in presence of an external electric field, the ellipsoidal bipolar particles form a chain parallel to field direction or stay apart depending on the inter-particle distance, as well as the relative strength and direction of external electric field. On the other hand, if th

05.08.03 Imaging Biological Tissues with Optical Coherent Tomography Based Elastography

Wei, Chen

University of Central Oklahoma

We present an optical coherent based technique to image elastic properties of the human thyroid. Based on the optimized kernel size for 2D normalized cross-correlation, the wavelet differentiation method was used to estimate the tissue strains. The influences of the dilation parameter of wavelet on calculations of axial strain had been investigated. Experimental results suggest that the dilation parameter of 8 was selected in strain calculation for best quality of axial strain images. The method based on wavelet differentiation shows great potential for optical coherence tomography elastography. In addition, elastic properties images of thyroid with suspected cysts were depicted to distinguish benign lesions qualitatively. Thus, elastic properties imaging based on optical coherence elastography shows great promise for the detailed characterization of lesions and preliminary diagnosis of human thyroid diseases.

05.08.04 Biological Mechanism of Nanotechnology and Near-Infrared Laser Irradiation

Wei, Chen

University of Central Oklahoma

Use of near-infrared laser irradiation and carbon nanotubes allows selective photothermal tumor cell destruction. Combined with immunological stimulation, using a novel adjuvant, we also observed the anti-tumor immune responses when treating animal tumors using the laser-nano treatment. The local application of laser-nano-immunotherapy appeared to result in a systemic curative effect. In our mechanistic study, we found that the laser-nano-immuno treatment can activate antigen-presenting cells, such as dendritic cells (DCs). More importantly, the uptake and presentation of antigens by these antigen presenting cells were significantly enhanced, as shown by the strong binding of tumor cells and DCs as well as the proliferation of T cells caused by the DCs after the DCs had been incubated with laser-nano-immuno treated tumors. These cellular observations provide evidence that a systemic anti-tumor immune response was induced by the combination of laser and nanotechnology.

05.08.05 Suppression of Microglial-Induced Neuroinflammation in LPS-Activated Microglia by Low-Power Laser Irradiation (LPLI)

Wei, Chen

University of Central Oklahoma

Microglial activation plays an important role in neurodegenerative diseases. Once activated, microglia have macrophage-like capabilities, which can be detrimental by producing proinflammatory and neurotoxic factors including cytokines, reactive oxygen species (ROS) and nitric oxide that directly or indirectly cause neurodegeneration. The regulation of microglial-induced neuroinflammation is considered a useful strategy in searching for neuroprotective treatments. In this study, we showed that low power laser irradiation (LPLI) (20 J/cm2) could suppress microglial-induced neuroinflammation in LPS-activated microglia. We found that LPLI-mediated neuroprotection was achieved by activating tyrosine kinases Src, which led to MyD88 tyrosine phosphorylation, thus impairing MyD88-dependent proinflammatory signaling cascade. Our research may provide a feasible therapeutic approach to control the progression of neurodegenerative diseases.

05.08.06 Inflatable Artificial Gravity Habitat Dynamics

Geoffrey, Kibble

Oklahoma State University

Future envisioned missions to deep space elicit problems and challenges not fully investigated by the world's spaceflight organizations. One of the most prominent issues is prolonged exposure to weightlessness. The human body functions day-to-day with the resistance and force of gravity; in the absence of this phenomenon, bones/muscles swiftly atrophy. Another alarming effect, which has been acknowledged in recent years, is loss of vision due to prolonged spaceflight. Researchers hypothesize that lack of gravity increases pressure on the optic nerve, thus causing vision loss. An effective way to generate a force similar to gravity is to rotate a body to produce centrifugal force. For a small scale investigation of this concept, the Oklahoma State University Space Cowboys team has designed an inflatable beam-rotating experiment. The effects of various internal pressures on the beam's stiffness and rotational stability will be examined. Inflatable structures are lightweight, have a high ratio of deployed to packed volume, and could provide sufficient support for a rotating spacecraft that produces an artificial gravity force. The experiment is designed to allow the deployment pressure to be altered between test runs (parabolas). As spaceflight becomes more ambitious and missions of longer duration become both desirable and possible, spacecraft designs must provide crew members with an Earth-like gravity environment.

05.08.07 Geometry Optimization of Aerodynamic Add-On Devices

Abdellah, Ait Moussa , Assal Alaee, Jeremiah Baker, Justin FischerRohan Yadav

University of Central Oklahoma

The rising trend in fuel prices has led to growing concern about vehicle fuel economy, and viscous drag is one of the main factors. Improvement in fuel efficiency can be achieved at a relatively low cost by installing aerodynamics devices to streamline vehicles and reduce drag. We report here an efficient numerical technique to optimizing the geometry of such devices. The technique combines shape optimization, geometric modeling, and Finite element analysis (FEA). To assess the validity of our optimization algorithm, we compare our optimization results against known test cases similar to the configurations in hand. We use this method to examine how effective add-on devices in reducing drag on a simple model of a commercial truck.

05.08.08 Design of an Unmanned Aerial Vehicle (UAV)

Baha, Jassemnejad , Ben Lamb, Josh Bischoff, Juan OrozcoTyler Grellner

University of Central Oklahoma

Unmanned aerial vehicles (UAVs) are defined as aircraft that are capable of flight without the need of a human pilot on board. Rapid development and advancement in motor, sensor, and control technology have brought about an increased interest in UAVs and their potential fields of research and applications. Due to smaller more efficient inertial measurement units, these vehicles have recently become a test bed for control systems development using advanced filtering methodologies. In this project, we have researched, designed, and are currently building a quadcopter to provide a mobile platform for data collection. We present an overview of the management of this multidisciplinary project including its planning, construction, and implementation phases. This project will provide the Engineering and Physics department at UCO with a sustainable source of research and the opportunity for the department to be represented in UAV competitions worldwide.

05.08.09 Development of Improved Autonomous Control System for Power Efficient UAV

Baha, Jassemnejad , Juan Orozco

University of Central Oklahoma

Unmanned aerial vehicle (UAV) applications have increased in the past years at unprecedented rates. The significance of UAVs, as well as their performance, is largely based on the control system employed and its interaction with the subsystems of the vehicle. This research includes the development, testing, and implementation of a smart control system that merges techniques from prominent control algorithms in order to improve autonomy and increase power efficiency of UAVs

05.08.10 High-Efficiency Solar Panel Implementation in Unmanned Aerial Vehicles

Baha, Jassemnejad , Ben Lamb

University of Central Oklahoma

The capabilities of unmanned aerial vehicles (UAVs) directly correlate with the power provided to the system. The purpose of this research has been to investigate the usage of highly-efficient photovoltaic modules with UAVs to increase their effectiveness. An assessment of various applications of solar cell integration is currently being accomplished through circuit analysis, field tests, and data collection.

05.08.11 Determining Efficient Position Mapping and Navigation in Autonomous Aerial Vehicles

Baha, Jassemnejad , Josh Bischoff

University of Central Oklahoma

Since their inception in the early 1960's, unmanned aerial vehicles have been growing in popularity due to their ability to carry payloads such as sensors, communications, and even warfare equipment. These vehicles operate without an onboard pilot so they must be able to make the decisions to affect the position and heading of the vehicle autonomously. These flight systems operate fully independently using programmable algorithms to accomplish the tasks of navigation and flight mapping. Advances in sensor equipment have popularized the use of global positioning systems to pinpoint a position on the Earth with a very accurate level of precision. This sensor data can be captured dynamically and analyzed over time to figure out the exact position, velocity, and acceleration of the vehicle. A comparison is made between the current coordinates and the desired path of travel to determine how an aircraft should react in order to minimize deviation. This research implements test procedures to investigate the most effective algorithms for autonomous navigation using GPS coordinates in aerial vehicles.

05.08.12 Utilizing Newly Available Frequencies for Communication with an Unmanned Aerial Vehicle

Baha, Jassemnejad , Tyler Grellner

University of Central Oklahoma

The use of unmanned aerial vehicles (UAVs) has expanded greatly in recent years. In 2009, the United States completed a transition from analog to digital broadcast television. This opened up the possibility that frequencies, previously used for analog television, could be allocated for other purposes. The unused frequencies are called the white space of the TV band. This research investigates the practicality, as well as the potential advantages, of using white space frequencies in the communications system of a UAV.

05.08.13 Design of a Digital Transmission Impairment Set

Baha, Jassemnejad , Brandon Woodyard, Jack Rouse, Keely ThompsonMontell Wright, Stephen Frosch

University of Central Oklahoma

Transmission Impairment Measurement Sets (TIMS) are devices that are widely used in the communications industry to test the performance and reliability of analog and digital transmissions and transmission media. TIMS provide the communications industry with a useful tool to analyze impairments a line might be experiencing and the information needed to isolate and correct problems, such as noise and data quality. Current TIMS are stand-alone devices that lack ability to automate necessary tests. Transitioning from standard stand-alone devices to user-defined devices allows for automation of the testing processes and helps with improving efficiency, accuracy, flexibility, durability, and functionality. When a signal is transmitted through communications equipment, that signal can experience alterations through processes such as distortion, attenuation and digital logic levels being incorrectly assigned. The main objective of this project is to develop a user-defined virtual instrument that will advance functionality and improve the quality of the transmission impairment measurements. This is being accomplished by developing a software application that utilizes a graphical interface environment, NI LabVIEW©, and data acquisition hardware.

05.08.14 Automation and Control of a Switching System

Baha, Jassemnejad , Clinton Quisenberry, Igor Ilikj

University of Central Oklahoma

This project explores the prospect of utilizing National Instruments (NI) hardware and software in order to create an automated switching system. The switching system can be used by any communication system, where there is a need for switching between different communication devices. The proposed hardware from NI is the NI PXI-2800, the switch block, which functions in conjunction with NI matrix relay cards. This is accomplished by the addition relay matrix cards that control how many switching points the system has. Depending on the size of the demarcation point or switch matrix, the system can be custom designed. Different matrix cards have different number of relays or switching points, and up to six of them can be configured per switch block carrier. The system can be controlled via NI LabVIEW integration, used by a desktop computer. Past work on the project includes a fully functioning simulation, which uses NI Measurement and Automation Explorer (MAX) in order to simulate the hardware described. The simulation is able to replicate the functionality of the actual hardware that would be deployed, which includes the PXI chassis, the switch block, as well as the matrix relay cards. The simulation is able to switch between the simulated input devices by closing the relays on the simulated matrix relay cards. The control is with the user, who is able to control which devices are connected.

05.08.15 Stent Enhancement Using a Locally Adaptive Unsharp Masking Filter in Digital X-Ray Fluoroscopy

Dr. Yuhao, Jiang , Eranda Ekanayake

University of Central Oklahoma

Fluoroscopy images are quantum limited. Simply reducing exposure will increase the percent noise to unacceptable levels. Unsharp masking filter has a long history in image enhancement. It is a very popular and simple contrast enhancement method that is amenable to real-time implementation in high frame-rate fluoroscopy. In a typical unsharp masking processing, the background will be estimated and then subtracted from the original input image to create a foreground image mainly containing objects of interest. The object image will then be amplified by a gain factor and added back to the original input image. The background estimation has been critical in unsharp masking processing. We use oriented filter kernels followed by a non-linear operation in order to get a kernel best approximating the background surrounding an object of interest. We also apply a spatio-temporal channelized human observer model to characterize the response of the filters. We use computer generated synthetic images to conduct experiments.It is shown that the locally adaptive unsharp making filter is an effective filter for the improvement of stent visibility in the interventional fluoroscopy. Results are compared to conventional unsharp mask processing and indicate this new unsharp making filter is advantageous in term of both less noise boosting and improved contrast of the stent.

05.08.16 The Effects of Laser Immunotherapy on Tumor Microenvironments

Joseph, Acquaviva , Ethan Wood, Melville Vaughan, Wei Chen

University of Central Oklahoma

The microenvironment of tumors plays a central role in the progression of cancers. In particular, fibroblast cells can facilitate the malignant progression of tumors. Specifically, the expression of alpha-smooth muscle actin is a hallmark sign of malignant cancer progression. Any cancer therapy must directly address the effects of the treatment on fibroblast cells. Laser immunotherapy (LIT), an innovated treatment for metastatic cancer, utilizes laser irradiation, laser absorbing dye, and immunological stimulation. While LIT has shown promise in treating metastatic cancer patients, the effect on the tumor's microenvironment is not well established. To better understand the effects on the microenvironment, a series of studies were conducted. First, human fibroblast cells were plated on coverslips and irradiated at different wavelengths for a specific duration, as well as incubated with the immunostimulant glycated chitosan. Then, the coverslips were stained for proliferation and alpha-smooth muscle actin expression. Furthermore, to model a tumor stroma, collagen lattices were created and injected with fibroblast cells. The lattices were irradiated on the 4th day of incubation and released on the 5th day of incubation. The change in lattice diameter in each treatment group was determined and analyzed. Additionally, lattices were stained for proliferation and alpha-smooth muscle actin expression. These studies will determine if LIT induces alpha-smooth muscle actin expres

05.08.17 Nanotechnology and Phototherapy: A Novel Treatment Modality for Metastatic Cancers

Joseph, Acquaviva , Feifan Zhou, Wei Chen

University of Central Oklahoma

While conventional cancer therapies have proven effective in treating solid primary tumors, their efficacy dramatically decreases in treating metastatic cancers. To successfully treat metastatic cancers, a systemic treatment is required. Laser immunotherapy is an innovative systemic treatment which induces an effective immunological anti-tumor response. This treatment synergistically incorporates laser irradiation (phototherapy), immunological stimulation, and a laser absorbing dye. In clinical trials, laser immunotherapy has shown great promise in treating late-stage metastatic cancer patients. Recently, single-walled carbon nanotubes (SWNTs) were integrated with the immunological stimulant, glycated chitosan (GC), to create a novel compound – immunologically modified carbon nanotube (SWNT-GC). In cellular studies, SWNT-GC has proven capable of entering cancer cells, increasing thermal destruction of tumors, activating dendritic cells, increasing T-cell proliferation, and increasing T-cell infiltration of tumor sites. In animal studies, SWNT-GC and phototherapy proved effective in treating rats with cancer. Furthermore, when primary tumors were treated with SWNT-GC and phototherapy untreated tumors decreased in size. To determine the potency of this novel treatment, animal and cellular studies were conducted using a more aggressive cancer cell line.

05.08.18 The Tension-Generating Ability and Appearance of Myofibroblast Tension Phenotype by Precancerous Cells, Ker-CT-Ras

Jessica, Webb , Melville Vaughan, Morgan Black, Sonnie Gainer

University of Central Oklahoma

Recent research activity has focused on the tumor stroma. Tumor stroma are typically connective tissues containing fibroblasts and myofibroblasts. These cells are required for the wound healing processes of the body. There is evidence that myofibroblast presence in tumor stroma leads to poor prognosis. Mechanical tension, one of three key factors, enhances differentiation of myofibroblasts. Precancerous keratinocytes lead to two types of carcinomas. In vitro carcinomas can form hrough a pathway which involves the up-regulation of the ras protein. They take on properties of fibroblasts and metastasize, spreading into the dermis. Fibroblasts generate tension in the dermis during the wound healing process. Our experiment focuses on keratinocytes and their journey into the dermis. We used Grinnell's stress-relaxation collagen matrix model, a model that provides the necessary microenvironment for myofibroblasts. The model was originally used to investigate the properties of fibroblasts, cells native to the dermis. Our research has taken to using it in the research of invasive epithelial, precancerous cells called Ker-CT-Ras. Previously, we set up Ker-CT-Ras lattices void of fibroblasts. Now, data will be presented on the comparative tension-generating ability of fibroblast lattices (DP-147-H-Tert) and co-culture lattices of the two. Also, we will present preliminary data from a monolayer (coverslip) model to describe structural properties of the myofibroblast phenotype.

05.08.19 Computational Model for Understanding Ciliary Mechanics

Miciah, Guy , Gang Xu

University of Central Oklahoma

Cilia and flagella are nanoscale hair-like structures that bend actively to propel cells or move fluid and materials in airways and other passages. Cilia and flagella undergo large bending deformations that are driven by molecular dynein motors fueled by ATP reactions. The genetics and biology of cilia are under intensive study, but the mechanics of their function remain unclear. In this study we build two-dimensional (Fig. 1) and three-dimensional models of flagella using finite element analysis software. To study the mechanical properties of flagella we apply theoretical loads to these computational models and analyze the deflection and stress distribution throughout the virtual flagella. The data obtained from these models will contribute to future experiments done in the lab on live Chlamydomonas reinhardtii flagella. The overall goal of this research is to answer two overarching questions: (1) “what are the structural basics of the mechanical properties of flagella?” and (2) “how the structural mechanics of flagella affect their active bending?” As mentioned above the study of the mechanical properties of flagella is an area that is still relatively untouched but I believe we can change this with our modeling and our experiments.

05.08.20 Development of a Virtual Frequency Shift Keying Modem

Baha, Jassemnejad , Thiago Omena

University of Central Oklahoma

The need for a more accurate and efficient method to transmit data over long distances has increased drastically since the introduction of the Internet. The employment of a Virtual Frequency Shift Keying (FSK) modem can significantly improve the performance, durability, and cost of stand-alone FSK modems used in the communications field. The purpose of this research has been to investigate and analyze the development of a software-based FSK modem using a graphical programming environment, NI LabVIEW, and data acquisition hardware.

05.08.21 Statistical Analysis of Chemical Accidents

Stephen, James , Qingsheng Wang

Oklahoma State University

Numerous incidents have occurred in the process industries and caused hundreds of fatalities and injuries. The US Chemical Safety Board (CSB) has conducted incident investigations as one element of the Process Safety Management (PSM) program and provided final reports for over 75 incidents. This paper is to look into all those final reports and summarize the findings. The type of accidents is identified as vapor explosion, dust explosion, reactive chemical explosion, and toxic chemical release. The main type of accidents is found to be vapor explosion that resulted in about 40% of all the types of accidents. Through the comprehensive analysis of PSM violations, the results show that mechanical integrity, process safety information, and process hazard analysis are the top three types of violations while about 20% of the PSM violations are due to mechanical integrity. The results also show that about 80% of these incidents are somehow due to human error. Detailed human error analysis for all these incidents is performed and the results show that lack of training is the main contribution to incidents. Recommendations are given to each type of incident that occurred based on the analysis results. This research is supported by the National Science Foundation (NSF) through OK-LSAMP to develop learning from incidents and therefore to improve process safety.

05.08.22 Data Acquisition System for Fluid Dynamics Research

Lillian, Seay

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The proposed project will be designed to examine the flow in microjunctions using cutting-edge energy generation techniques. Using these techniques, we will have an alternative view of how a fluid behaves during microfluidic flow. This will give other researchers a better understanding of the energy losses in any microfluidic system. My project is in the process of updating the current data acquisition system used to calculate the energy losses during microfluidic flow. The system is being updated by using a different microcontroller to incorporate more pressure sensors and flow meters. The microcontroller used in the new data acquisition system is sufficient because it can output more data than the one used currently. The updated data acquisition system will expand the ability to record more data from a variety of spots in the microchannel. With more data output, we will get an explicit image of the local details of energy loss in a system.

05.08.23 Probing Mechanical Stresses in Human Fibroblast Collagen Lattices

Lauren, Tlnnin , Cory Anderson, Gang Xu, Khiet TranMelville Vaughan

University of Central Oklahoma

The objective of this research project is to probe and quantify the mechanical tension generated in an in vitro dermal equivalent model for studying wound healing. Structurally supported by circular plastic mesh rings, the dermal equivalent is made of the collagen lattices co-cultured with human fibroblasts. After incubation, we probed the mechanical stresses in these dermal equivalents by removing a small circle of tissue with a biopsy punch and observing the following expansions of the wound. The results indicated that there exist considerable tensions in these dermal equivalent lattices. In addition, we studied the effect of a transforming growth factor, TGF-β, on the tension generation of the dermal equivalents. Understanding the biomechanics of these models will be an important step in studying mechanisms of wound healing and related cancer progression.

05.08.24 A Controller of Laser Irradiation for the Treatment of Metastatic Cancer

Joseph, Acquaviva , Jacob Prichard, Nhung Ngo, Paul Faryna

University of Central Oklahoma

Laser immunotherapy developed by Dr. Wei R. Chen and collaborators has successfully treated late-stage metastatic cancer patients. This innovative treatment incorporates a laser absorbing dye, laser irradiation, and an immunoadjuvant. While this therapy has shown great promise, the optimization of the treatment has not yet been achieved. Studies have suggested that laser irradiation is paramount for a successful patient outcome. Therefore, our group has developed a system to control laser irradiation during treatment. This system utilizes thermistors to precisely determine the temperature at the treatment site. These thermistors are inserted at specific locations in the tumor and have a 0.1◦C accuracy within the 25-115 ◦C temperature range. An electronic system is used to process and record the temperature measurements. These measurements are used in the Penne's Bioheat Equation to determine the laser modulation needed to achieve an optimal temperature distribution. Additionally, using LABVIEW, a user-interface was created to displays critical information for the successful treatment of the patient. This user-interface will reveal the current temperatures at the treatment site, the optimal temperatures at the treatment site, and the required laser modulation to achieve an optimal temperature distribution.

05.08.25 Design and Construction of Fatigue Test Setup to Evaluate Fiber Coated Hip Implant

Zhaoong, Meng , Kate Foran, Paul Snow

University of Central Oklahoma

The hip is an important multifunctional joint subject to position change, bending, and extreme force, causing wear on the joint. Imperfection of the hip implant device causes pain and swelling at or near the hip joint, change in walking ability, and popping in the hip joint. An electrospun micro/nanofiber coated hip implant decreases the spread of toxic particles from the implant material, causes higher adhesion which increases the strength of the implant while decreasing the risk of hip implant breakage and/or failure. The goal is developing an efficient bond interface between the implant and the cement by applying micro/nanofibers to the surface of the implant through an electrospinning process, utilizing biocompatible fibers. Experimental and numerical setups are designed to imitate the forces experienced on the hip through a cyclic fatigue test simulating walking. An uncoated cylindrical model was simulated and tested under static structural analysis. The fatigue test setup for cylindrical and implant models was designed and constructed. For future study, a biocompatible electrospun aligned fiber (300μm-9nm) will be synthesized and produced, using a PCL/collagen mixture. Under physiological walking conditions, aluminum implants with and without the electrospun fibers will be tested to determine fatigue life and then compared to the numerical simulations.

05.08.26 Alternative Monomer Effects on the Exothermic Temperature of PMMA

Zhaoong, Meng

University of Central Oklahoma

Poly Methyl Methacrylate (PMMA) bone cement produce exothermic reaction during its polymerization process, which damage the surrounding bone tissue. Nanoparticles additives can be incorporated with the PMMA cement to reduce the exothermic reaction. Previous study of “Exothermic Temperature Measurements of Novel PMMA Bone Cements” found that adding of nanoparticles decreased the curing temperature of the bone cement. Higher weight percentage of nanoparticles added in PMMA resulted in lower exothermic temperature. The system which consisted of 4-channel thermocouple (InstruNet Inc.), data acquisition device, data acquisition software and laptop, was established in the previous study. The purpose of this project is to measure temperature changes in PMMA cement samples having alternative monomers during curing. CobaltTM HV bone cement (CBC), a commercial orthopedic bonce cement, was used as PMMA bone cement. Selected 2%, 6%, and 10% (w/w) of monomers (3MPMA, GMA) were mixed with MMA monomer and then added into the PMMA beads maintaining the solid: liquid ratio of 2:1. The study found that addition of 3MPMA to monomer decreased the maximum curing temperatures of specimens, but the addition of GMA to monomer decreased the curing time of the specimens.

05.08.27 Wind Tunnel Measurements of Aerodynamic Drag on Road Vehicles

Nick, Chalifoux , Abdellah Ait Moussa, Jeremiah BakerMicah Guy

University of Central Oklahoma

The rising trend in fuel prices has led to major concerns about vehicular aerodynamics. Bluff bodied vehicles such as trucks and sport utility vehicles have a geometry that is prohibitive to fuel economy; with an increase in drag there is a consequential rise in the fuel consumption. Several methods were suggested to reduce aerodynamic drag; one is through the use of add-on devices. In another research, we devised a numerical scheme to simulate the air flow around these vehicles, and optimize the geometry of add-on devices for maximum reduction in drag. In this research, we devise the set up and devices needed for experimental measurements. Comparison between simulations and experimental results is also included.

05.08.28 Home Automation System

Amy, Gueye , Charlotte Chea

University of Central Oklahoma

1) Objective: To investigate the algorithms of speech recognition by programming and to stimulate the designed system in MATLAB and LABVIEW converting an ordinary home to a smart home. 2) Thesis: Home Automation System provides a higher security home, promotes energy saving and improves the living conditions of people with disabilities. 3) Methodology: a) Filtering: To filter out noise from the speech signals. b) Speech segmentation: To figure out the algorithms to segment speech signals. c) Speech Discrimination: To produce MATLAB programs that are able to distinguish different words. d) Decision Making: To execute the right commands for the input signals. e) Accuracy: To achieve at least a 70% accuracy in turning on or off the right home device. 4) Summary: The written MATLAB programs will be burnt to a device called NI myRIO for practical usage. Eight devices were chosen as target devices for this project. The deliverable of this project is to turn on or off those eight devices correctly. The system should have the ability to distinguish between the words ‘ON’, ‘OFF’, and the eight devices’ name. The eight devices are: ‘TV’, ‘RADIO’, ‘LIGHT’, ‘CURTAIN’, ‘DOOR’, ‘AC’, ‘FAN’, and ‘GAME’.

05.08.29 Quantitative Assessment of a Second-Order Bio-heat Transfer Model for Thermography-Derived Perfusion Imaging

Vasumathi, Chalasani , Daqing Piao

Oklahoma State University

Assessing perfusion is important to management of soft tissue injury. Previous studies have demonstrated that information indicating cutaneous perfusion can be derived from dynamic thermography imagery by applying bio-heat transfer models. These previous methods for thermography-derived perfusion imaging, however, have been largely based upon a first-order bio-heat transfer model that over-simplifies thereby missing higher-order information. In this study we develop a second-order bio-heat transfer model for deriving perfusion information from thermography imagery. A simulation study is undertaken for quantitative assessment of the improvement of the thermography-derived perfusion by the second-order model versus the first-order model. A series of thermography data are generated in correspondence to a set of bi-polar perfusion maps, and noise levels of 0.1%, 1%, 2%, 5% & 10% are added to the simulated thermography maps for being processed using the first-order and second-order bio-heat transfer models, respectively. The contrast-to-noise ratio analysis out of the synthetic measurements demonstrates that a second-order bio-heat transfer model is substantially more accurate in the estimation of the perfusion level and more robust to noise than a first-order bio-heat transfer model. The improvement in thermography-derived perfusion by using a second-order bio-heat transfer model is also shown when in-vivo thermography imagery is processed.

05.08.30 Determination of Loss Coefficients and Entrance Lengths using the Entropy Generation Method

Brock, Ring , Evan Lemley

University of Central Oklahoma

Two important fluid dynamics concepts are entrance length and loss coefficient. The entrance length is the downstream distance required for flow to reach a state that is unaffected by a change in the bounding geometry. In most scenarios, the entrance length is approximated using the fluid parameters, characteristic length of the tube, and the average fluid velocity. This approximation yields a result that must be overcompensated due to minor variations that can occur in experiments. The loss coefficient is a parameter that allows easy calculations for the energy losses through junctions. This parameter is typically impossible to determine analytically, requiring empirical data to deduce a value. Historically, this has been done by taking pressure and flow rate measurements upstream and downstream from the junction, effectively treating the junction as a “black box.” This research aims to use a Particle Image Velocimetry (PIV) system to use the velocity profile to determine these values. The velocity profile gives all of the information about the fluids motion. This data can be used to look inside the junction and observe how the energy is being lost.

05.08.31 Design and Implementation of a Multi-Dimensional Staging and Flow Measurement System for Particle Image Velocimetry-based Fluid Dynamics Research

Brock, Ring , Brody Tucker, Evan Lemley, Rodney Worthen

University of Central Oklahoma

Flow through junctions has been studied in detail for turbulent flow. This is largely due to turbulence being the more common condition in macro sized junctions. However, in micro scale applications this is not the case. Laminar flow tends to occur much more frequently than turbulence in the smaller sized networks due to the high pressure differentials required to force fluid at a rapid rate. Loss coefficients under the turbulent condition tend to remain constant for a particular geometry with respect to the Reynolds number, whereas, laminar flow tends to result in loss coefficients that are highly dependent on Reynolds number. By matching the Reynolds number, larger scale experiments can be done using a Particle Image Velocimetry (PIV) system. This project aims to provide initial research into the energy losses in junctions under laminar flow. These losses are calculated using differential pressure sensors as well as a PIV system used to determine the entropy generation rate. The junction studied is a tee with varying rounding on the edges and a square cross section. The results are the loss coefficient versus the Reynolds number for each tee junction. Many textbooks have a catalog of loss coefficients for different types of junctions. The issue is these parameters are only good for the turbulent condition. This project will help catalog the outcome of laminar flow through a tee junction with a square cross section.

05.08.32 Automation and Remote Control of an Astronomical Observatory in Northwest Oklahoma

Baha, Jassemnejad , Scott St John

University of Central Oklahoma

The objective of this research project is to investigate measures for automating and remotely accessing the observatory telescope and associated enclosures in Northwest Oklahoma. The telescope can be controlled over the internet via commercially available observatory software, using wireless internet present on site. Orientation sensors give feedback on the positions of the domed enclosure and the telescope to an automated controller, which then relays commands to the motor controlling the dome. The dome can then follow the movement of the telescope with no input required by the user. In the event of a lost signal, the dome will be designed to close itself and power down. A digital camera relays the view of the telescope back to the user at the other end of the connection. By controlling the length of the exposure, vivid images of faint, deep-sky objects can be made.

05.08.33 Modular Optical Tweezers as a Tool for Cancer Research

Baha, Jassemnejad , Brian Reed, Cody Bahavar, Gang XuWei Chen

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The goal of this project is to use optical tweezers (OT) to study the effect of laser illumination on individual tumor cells. Since its inception, trapping and manipulation of single cells or microscopic dielectric particles with a focused laser beam has provided a powerful tool in the field of molecular and cellular biophysics. We have developed an OT system that is completely modular; that is, the OT apparatus is entirely composed of breadboard components. This innovative approach to OT construction is utilized here to trap individual metastatic mammary tumor cells. Different than the laser immunotherapy for the tissue level treatment, for the first time we examined the effect of focused laser illumination on the cytoskeletal structure of single tumor cells as indicated by changes in the thermal fluctuations of the cell body in the trap. The results will provide important information on the biophysical mechanisms of the laser immunotherapy.

05.08.34 Single fiber reflectance spectroscopy measurements need to be normalized using geometry-specific methods

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Single-fiber reflectance spectroscopy (SfRS) is used for minimally-invasive probing of some biological tissues. In order to extract tissue optical properties, it is necessary to normalize tissue spectrum against spectra from two reference materials. The materials that are used for reference include diffuse reflectance standards, 20% bulk intralipid, water & air. However, there is no clear consensus regarding which combination of reference materials provides the most accurate and convenient normalization. As SfRS measurements depend upon the probing geometry, such as infinite or semi-infinite geometry, it is important to use normalization method specific to the respective measurement geometry. This study demonstrates simple analytical modeling for evaluating outcomes of using different reference materials for normalization. We compare normalization of experimental interstitial SfRS using different combinations of two reference materials as reported in literature: 1)two reflectance standards of high & low reflectivity, where semi-infinite geometry is implied; 2)reflectance standard & water, in which there is a mixture of semi-infinite and infinite geometries; 3)20% intralipid & water, to which infinite medium geometry applies; 4)air & water, where infinite medium geometry applies. It is demonstrated that SfRS normalization of biologically relevant medium (μs' of 1.0mm-1 or less) can introduce significant systematic bias if normalization is not geometry-specific.

05.08.35 Wireless Patient Vitals Monitor

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The purpose of our project is to research and design; prototype, and assemble a wireless patient vitals monitor. Our product will be cheaper than products currently available on the market with cost efficient parts and sensors. To start the development of our product, we decided to utilize the Arduino chipset microcontroller. We intend to use wireless transmission to increase patient comfort and mobility. To focus our research, we concentrated our efforts to three body vitals; heart rate, respiration rate and surface body temperature. We have built an electrocardiogram monitor to measure the heart rate of a patient. To measure the respiration rate, we have incorporated pressure sensors along a fabric that would be worn around the chest which would indicate the rate of breathing. Our temperature measurement would be provided by a digital temperature sensor that would be in contact with the patient's skin. We will transmit our collected data using Bluetooth transmission to a computer base station. Our data will then be processed using LabVIEW to display the collected data in an appealing graphical user interface. Key words: Bluetooth, Pressure sensor, Electrocardiogram, Temperature sensor, Arduino Uno, Wireless monitor, LabView

05.08.36 Biomechanical Characterization of Algal Motility in Response to Medium Viscosity

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The goal of this project is to use engineering methods to correlate cellular motility and gene expression of the green biflagellate alga Chlamydomonas reinhardtii in response to altered physical stimulation, specifically medium viscosity. The ultimate objective is to improve our understanding of the biophysical mechanisms for cilia-related diseases. Algal cells were cultured in mediums with various viscosities resulting from different concentrations of methylcellulose. The motion of individual cells was recorded with a high speed digital camera under a microscope. Videos were analyzed using a custom MATLAB tracking program to trace movement of the cell center in space and time. The average swimming velocity of each cell was calculated by dividing the total distance traveled by the total time. This method was used to track and compare the average swimming velocities between cells under different viscous mediums. Our data suggest that the flagella-driven cellular motility decreases with elevated medium viscosity. This specific motility change will be correlated to changes in gene expression in order to provide better understanding of the coupling between the mechanics and the genetics of the flagella and cilia.

05.08.37 Design and Construction of a Micropipette Manipulation System for Cellular Biophysics Research

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The purpose of this project is to design and create a micropipette aspiration and manipulation system that will allow us to manipulate single cells and measure their micromechanical properties. The micropipette manipulation system is one of the major techniques in the research areas of molecular and cellular biophysics and biomechanics. Based on the principles of fluid mechanics, this technique can be used to apply or measure small pico-Newtown forces on cells and molecules during, for example, cell-cell adhesion. Our system consists mainly of a custom-made glass micropipette in connection with a hydraulic reservoir. A spherical object that snugly fits inside the micropipette, either a cell or a microsphere, can serve as the force transducer. When a hydraulic pressure is imposed across the force transducer by adjusting the relative height between the micropipette and the reservoir, a small viscous drag can be achieved on the force transducer which then applies directly on the object in contact with the force transducer. In this presentation, we will discuss more details in the principles, design, and construction of a completed micropipette system, as well as its applications in our ongoing cell biomechanics research.

05.08.38 Effects of laser immunotherapy with cyclophosphamide for the treatment of metastatic cancer

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Laser immunotherapy (LIT) is an innovative cancer modality that uses laser irradiation and immunological stimulation to treat late-stage, metastatic cancers. The current mode of operation in LIT is through interstitial laser irradiation. Although LIT is still in development, recent clinical trials have shown that it can be used to successfully treat patients with late-stage breast cancer and melanoma. Cyclophosphamide is a chemotherapy drug that suppresses T-regulatory cells. In this study, tumor-bearing rats will be treated by LIT using an 805-nm laser with a power of 1 to 3 W and various doses of cyclophosphamide. Glycated chitosan will be used as an immunological stimulant. The goal is to observe the effects of differing doses of cyclophosphamide in addition to LIT on the survival of the tumor-bearing rats.

05.08.39 Design of an Experimental Apparatus to Examine Inlet Geometries and Flow Characteristics of Developing Flow in Rectangular Channels

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Compared to the amount of research that has been done on fully developed flow, there has not been as much on flow before it is fully developed (developing flow). Of the research that has been completed, there is even less that has been done on channels having a rectangular geometry. To better understand the flow characteristics of the combination of these two under researched flow problems, we will be utilizing particle image velocimetry (PIV), a method of actually visualizing how the fluids are moving through a channel, to first observe the fluids at the inlet of the channel, then to analyze the developing fluid up to that point when it becomes fully developed. There are of course, mathematical formulas and computations that can be done to calculate what is theoretically happening in these channels, but as is often the case, there are discrepancies between known calculations and what an experiment actually yields. This research will be very useful to future experiments done on developed flow, because there will be an experimental result to support or deny a known analytical model for determining when flow is actually fully developed. This will ensure that experimental apparatuses are manufactured to a necessary length to perform the desired experiment. Furthermore, this research will lead directly into a study of entropy generation in rectangular channels, which will be very useful as rectangular micro channels becomes common place in electronics and bio-medical sciences.

05.08.40 Energy Losses of Fluids as a Function of Entropy Generation

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Energy losses of fluids is a topic of interest in the field of fluids engineering. By altering the channel aspect ratio (height to width ratio) and the junction shape (square or curved), experimental flow data can be compared with previously obtained experimental values, computer simulation, and theoretical values to maximize flow system optimization. Data will be obtained through a combination of pressure drop and volume flow rate and separately with particle image velocimetry (PIV) measurements. The focus of this project is to investigate the effects of junction shape on entropy generation rate. By determining the entropy generation rate of a system, the energy lost due to friction of a flowing fluid can be found. This energy loss can be described as a dimensionless quantity which will be referred to as the loss coefficient. Finding this loss coefficient is important because it is an invaluable part of improving the efficiency of any given system involving fluid flow. This particular type of research is a growing interest as modern day engineering requires more effective ways of delivering the needs of society. Currently, determining the loss coefficient in a junction is only an approximation as certain assumptions are required. On-going experiments use sharp square corners in the junction, data from rounded corners will be compared to previously obtained experimental data from square corners to investigate the effects of rounded corners on entropy generation rates.

05.08.41 Three directional Accelerometer with application

Quinten, Walker

Langston University

In this research I will demonstrate the use and the functionality of a three directional accelerometer, specifically of the capacitive type. I will also perform several analytical checks to test the accelerometers' effectiveness as well as its' ability to accurately sense a given direction. The primary focus of directions will be on x, y, and z axes to view the 3d orientation in space. I will introduce what an accelerometer and its primary purpose, furthermore, this work will cover the basic principles and concepts of three directional on how accelerometer operates. The results will be simulated and proven mathematically using matlab. This research will extend itself into an original application demonstrating a possible use of a three directional accelerometer; and the results will be given to determine the accuracy of the application as well.

05.08.42 Innovative Shear Stress Sensing Technique Using Liquid Crystal

Alaeddin, Abu-Abed

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In this presentation, the authors present a new technique in measuring shear stress forces using capacitive-based liquid crystal sensor. In this work, the authors have developed an alternative method which utilizes LC film embedded in an interdigital capacitive microstructure. This innovation will transduce the shear force, which deforms the LC profile, into a measurable capacitive quantity via tracking the LC deformation. This promising sensor has strong potential applications in bioengineering systems where monitoring the blood shear stress is critical such as carotid artery experiments. Some of the issues addressed in this work are the impact of the shear stress on the liquid crystal molecular ordering (order parameter) and the influence of electrode geometries and material properties on the measured capacitance.

05.08.43 Optimization of Data Acquisition for Micro Fluid Systems

Daniel, Atkinson

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In the field of micro fluids, data acquisition is an integral part of verification and validation of models and simulations. The data acquisition system (DAQ) must be able to process many sensor inputs for pressure and flow rate measurements effectively and efficiently for a junction or channel. This project redesigns the current system in use to achieve three goals. One, Modernization of the of the existing system to accommodate future additions. Two, the addition of flow meters to directly measure flow rate. Three, implementation of algorithms to better monitor the experiments being conducted and more quickly produce data.