FIU | Engineering & Computing

Department of Biomedical Engineering

BIOMEDICAL ENGINEERING SENIOR design EXPO

AN UNDERGRADUATE STUDENT PROJECT SHOWCASE & COMPETITION

SPRING 2024

DISCOVER | DESIGN | DEVELOP | DELIVER

Presented through the generous support of the Wallace H. Coulter Foundation

BIOMEDICAL ENGINEERING PRESENTS

Senior Design Project Showcase & Competition

Wednesday, April 17, 2024

The Biomedical Engineering Senior Design Showcase & Competition is the culminating experience for undergraduate seniors in Biomedical Engineering. Teams of senior students complete and present their capstone projects, which entails the design and manufacture of a prototyped medical device, process, or software system solution to address unmet biomedical needs.

Congratulations
Graduating Seniors!

Jorge Riera Diaz, Ph.D.
Associate Professor,
Interim Chair of Biomedical Engineering

CHAIRPERSON MESSAGE

As senior Biomedical Engineering students at Florida International University, you have come to the end of an incredible journey. Your Senior Design Projects are a reflection of your efforts and your capstone undergraduate experience.

Your work is an illustration of the many skills you have sharpened during the course of this yearlong project. You have discovered new ways of thinking, designed and developed an engineering solution for a practical problem, and collaborated with your teammates to deliver innovative solutions. It is encouraging to see your accomplishments and to have witnessed your growth as students.

As you embark on the next stage of your education and careers, keep the confidence that comes from having enhanced your knowledge, remain inquisitive and have the courage to achieve your dreams.

Best wishes for continued success,

Jorge Riera Diaz

AGENDA

SPRING 2024 COMPETITION - WEDNESDAY, APRIL 17th, 2024

Room EC 2300

7:30 AM

Breakfast

8:15 - 8:30 AM

Introduction & Orientation - Dr. Michael Christie, Associate Teaching Professor

Welcome Remarks from Dr. Wei-Chiang Lin, Associate Professor and Acting Undergraduate Program Director

Instructions to Judges - Dr. Christie

8:30 - 11:15 AM

Oral Presentations

8:30 AM - Team 1
8:45 AM - Team 2
9:00 AM - Team 3
9:15 AM - Team 4
9:30 AM - Team 5
9:45 AM - Team 6
10:00 AM - Team 7
10:15 AM - Team 8
10:30 AM - Team 9
10:45 AM - Team 10
11:00 AM - Team 11
11:15 AM - Team 12

11:30 AM - Keynote Speaker: Councilwoman Maureen Porras from the City of Doral

11:45 AM - Congratulatory Messages and Senior Design Montage

12:00 - 1:15 PM - Lunch in Panther Pit

1:15 - 1:30 PM

Awards Ceremony with Dr. Wei-Chiang Lin, Dr. Riera, Dr. Christie & Professor Shahrestani

Congratulatory Message from Dr. Inés R. Triay, Interim Dean of College of Engineering and Computing

Certificates of Concentration - Dr. Lin

Presentation of Senior Design Project Awards Spring 2024

Word of Thanks and Concluding Remarks - Dr. Jorge Riera, Associate Professor and Interim Chair

TEAM PROJECTS

SPRING 2024 ORAL COMPETITION - ROOM EC 2300

8:30 AM - Team 1: Device for Precise Localization of the Pelvic Region to Facilitate CAT-CAM Socket Fitting in Transfemoral Amputees (P-ELVIS)

8:45 AM - Team 2: 1Phren

9:00 AM - Team 3: Semi-Automated Fecal Microbiota Processing System (S-AFMPS)

9:15 AM - Team 4: DetruPulse

9:30 AM - Team 5: E-CAE Detection Device

9:45 AM - Team 6: HeartSim Pro

10:00 AM - Team 7: Deinde Head Stabilizer 2.0

10:15 AM - Team 8: Wireless, Low-Power Sleep Monitoring Device

10:30 AM - Team 9: The Halo

10:45 AM - Team 10: Flexible Remateable Interconnects (FRIs)

11:00 AM - Team 11: Breathe EZ Retro Nasal Steam Inhaler

11:15 AM - Team 12: PHOED: Photonic Hemoglobin Oximetry Epidermal Device

11:30 AM - Keynote Speaker: Councilwoman Maureen Porras from the City of Doral

11:45 AM - Congratulatory Messages (Video Compilation) & Senior Design Montage

Team 1

Device for Precise Localization of the Pelvic Region to Facilitate CAT-CAM Socket Fitting in Transfemoral Amputees (P-ELVIS)

Faculty Mentor: Dr. Anamika Prasad

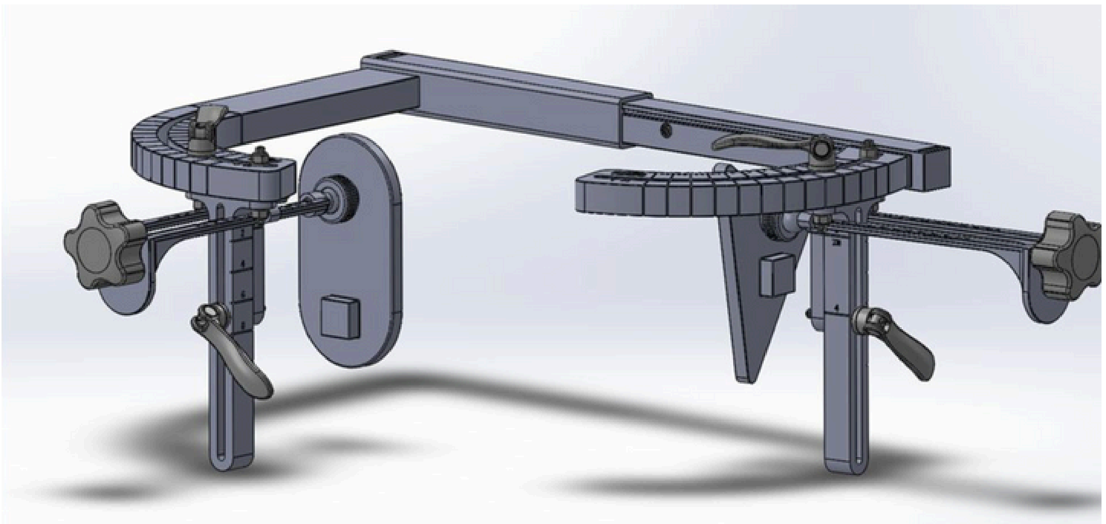
Project Sponsor:

BioSculptor
innovative solutions

*James Hoag, Abduson Orasmy, Karen Colmenares, Rinat Ran

Transfemoral amputations account for roughly 40% of all amputations performed globally annually, primarily attributed to diabetes. To help combat this, CAT-CAM (Contoured Adducted Trochanteric-Controlled Alignment Method) sockets are designed to fit closely with the ischial ramus, thus "locking" onto the pelvis and the upper part of the amputated leg, providing a secure and comfortable connection between the prosthetic limb and the body. Despite advancements in prosthetic technology, the fitting of CAT-CAM sockets remains reliant on manual measurements, leading to inconsistencies and suboptimal fittings that significantly affect patients' comfort, mobility, and quality of life while imposing financial burdens due to additional modifications and refittings.

Our solution significantly improves accuracy and precision in the CAT-CAM socket fitting process by eliminating the reliance on manual measurements. The device consists of an extendable bar that localizes the ischial ramus and two adjustable panels for the targeted application of pressure to shape the transfemoral limb and facilitate localization of the pelvic region for the scanning software. This solution aims to enhance accuracy and precision in socket fitting by eliminating variability linked to manual measurements, consequently improving the comfort, stability, and functionality of prosthetic limbs while reducing the need for costly modifications and refittings.



Team 2

1Phren

Faculty Mentor: Dr. Anamika Prasad

Project Sponsor:

BetaBlue

*Nico Scaringello, Jose Pena, Melanie Barros, Hussein Karaki

This senior design project presents the design and development of a neurostimulator that will be used to treat negative symptoms of Schizophrenia. This psychological illness is often overlooked within the medical field due to its elusiveness, with the main form of treatment being long-term pharmaceuticals (antipsychotics). Limitations within the industry has prompted an opportunity to introduce a more innovative approach in the way symptoms can be managed. Our solution involves the design and manufacturing of a wearable neurostimulator that will target the left abdominal section of the Vagus nerve. The device will implement wireless and efficient interferential stimulation to the targeted area. Electrode patches will be placed directly on the skin. The device itself will sit directly above the patches and will be secured around the waist using our poly knitted elastic belt with velcro straps. Through comprehensive research and engineering, the device addresses unique anatomical considerations of patients who suffer with Schizophrenia, providing an adjustable and comfortable belt strap to accommodate for any patient of any size or stature.

The project encompasses a multidisciplinary approach, incorporating principles of mechanical engineering, electrical engineering, and biomedical engineering. Prototypes of our device were designed using SolidWorks, 3D printed using PLA, and soldering was done to ensure proper packing and placement of the electrical components. Rigorous verification testing was done regarding stress and weight, as well as a frequency killer test being done using a phantom model. The results demonstrate the device's effectiveness in handling various forms of stress while maintaining efficient stimulated on the targeted area.

Furthermore, the project takes into account not only the technical elements but also factors such as practical deployment, cost-efficiency, and scalability, rendering it a viable option for broad clinical application.

Team 3

Semi-Automated Fecal Microbiota Processing System (S-AFMPS)

Faculty Mentor: Dr. Jessica Ramella-Roman

Project Sponsor:

ARDIG

*Shania Mair, Ivan Rivera, Paola Alvarado, Anashka Charles

This project focuses on the development of a Semi-Automated Fecal Microbiota Processing System to improve efficiency and reliability of fecal microbiota transplantation (FMT) procedures. FMT has become a crucial treatment for recurrent Clostridium difficile infections (CDI) by manipulating gut microbiota. However, current manual processing methods result in lower microbiota retention and are labor-intensive. This system aims to address these challenges by automating key processing steps while adhering to FDA regulations. The system consists of an initial mixing chamber with a mechanical mixer and a filtration chamber with two valves. One valve controls the amount of sample through two filters, and the other valve controls the transfer of the sample to the centrifuge tubes. The mechanical mixer ensures thorough mixing, while the filtration chamber removes coarse particles. Engineering analysis and decision-making processes were used to select the most suitable design concept. Feasibility assessments showed that the system will reduce costs and provide operational benefits, such as improved microbiota retention and reduced manual labor. The project plan includes a detailed task distribution and a timeline to make sure it is completed before the deadline. Overall, the goal of this project is to advance FMT processing efficiency, reduce labor requirements, and improve microbiota retention, contributing to better clinical outcomes and cost management in the treatment of CDI.

Team 4

DetruPulse

Faculty Mentor: Dr. Shuliang Jiao

Project Sponsor:

ARDIG

*Miguel Iniesta, Cristina Benedit, Sterline St Cyr

Approximately 305,000 individuals in the US live with a traumatic spinal cord injury (SCI) that leads to neurological conditions, such as urinary retention. Urinary retention is characterized by the incomplete emptying of the bladder during micturition. In SCI patients, urinary retention is caused by losing the connection between the brain and the spinal cord, where the signal sent by the brain to induce the micturition reflex does not reach the spinal cord. Although there are treatment options for these patients, the current modalities are invasive and are prone to cause side effects in the long term, which has prompted an increase in the demand for noninvasive alternatives. This project aims to create the DetruPulse - a noninvasive, portable neurostimulator employing the modality of interferential current to stimulate the T11-L2 spinal cord segments to restore the micturition reflex. As a tangible output, the DetruPulse constitutes a circuit that produces two high-frequency sinusoidal carrier waves capable of overcoming skin impedance whose interference results in a beat frequency capable of nerve stimulation deep within human tissue. Thanks to the implementation of this modality, DetruPulse aims to provide a treatment option that increases patient autonomy devoid of the risks associated with the current modalities.

Team 5

E-CAE Detection Device

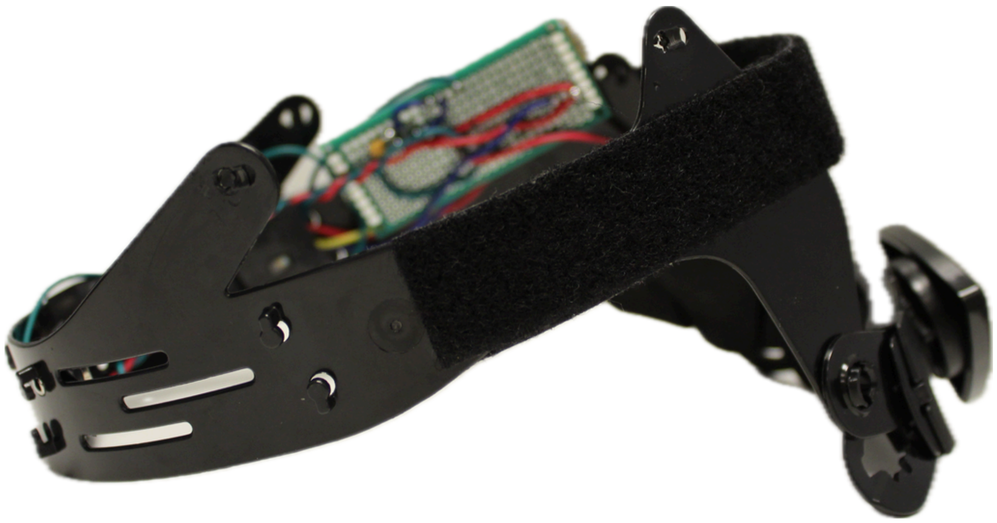
Faculty Mentor: Dr. Anuradha Godavarty

Project Sponsor:

ARDIG

*Katherine Lopez, Scarlet Saez, Tatiana Duran, Daniel Parrado

Childhood absence epilepsy (CAE) is a benign form of epilepsy characterized by sudden lapses in consciousness, often accompanied by a vacant stare and a temporary disconnection from the surrounding environment. This condition predominantly affects children ages 4 to 12, with an incidence rate ranging from 6 to 8 per 100,000 individuals. Existing monitoring devices lack real-time capabilities and comprehensive data analysis features, presenting challenges for caregivers and healthcare professionals in detecting and responding to absence seizures in real-time. To address this clinical challenge, the E-CAE project focuses on developing an absence seizure detection device that features strategically positioned sensors, including EEG electrodes, a temperature sensor, and a PPG/heart rate sensor, integrated into a comfortable headband-style device. The device facilitates physicians in effectively treating CAE by offering valuable insights and data for optimizing treatment strategies. The E-CAE device aims to improve outcomes for children with CAE by enabling early detection and intervention, optimizing treatment approaches, and enhancing overall quality of life.



Team 6

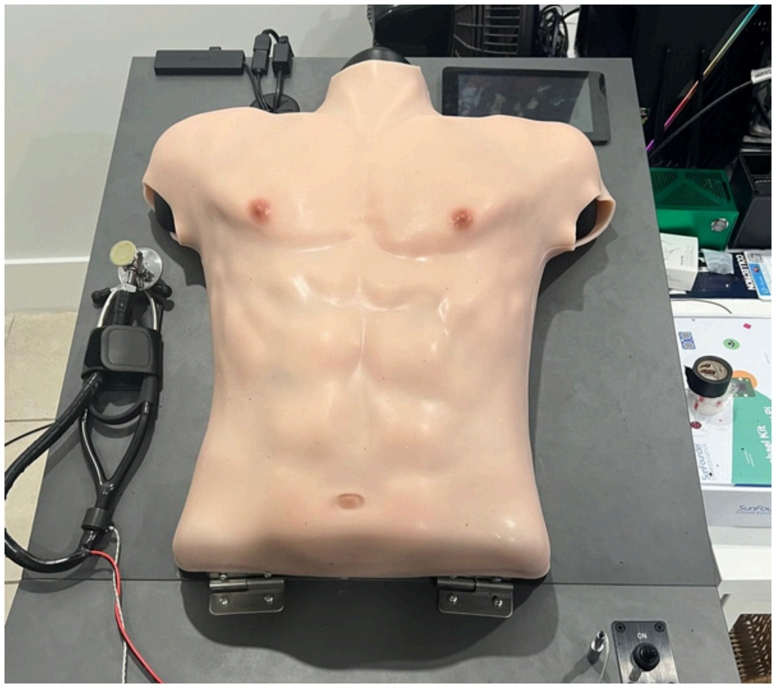
HeartSim Pro

Faculty Mentor: Dr. Joshua Hutcheson

Project Sponsor:

*Alejandro Perez, Adrian Marin, Ahmed Assad, Faria Uddin

Stethoscope usage and confidence has recently dwindled while cardiovascular disease misdiagnosis has been becoming fairly common. Current cardiovascular patient simulators are outdated, using older technology to simulate the cardiovascular anatomy of the average patient. Our patient simulator offers a cheaper and possibly more efficient method of both usage and manufacturing. Four receiver coils and one transmitter coil (embedded into the stethoscope) offers a very hands on and responsive method to increase the confidence and usage of stethoscopes for medical trainees and possibly current professionals. The transmitters, receivers, and other software/hardware work with a Guided User Interface (GUI) App.



Team 7

Deinde Head Stabilizer 2.0

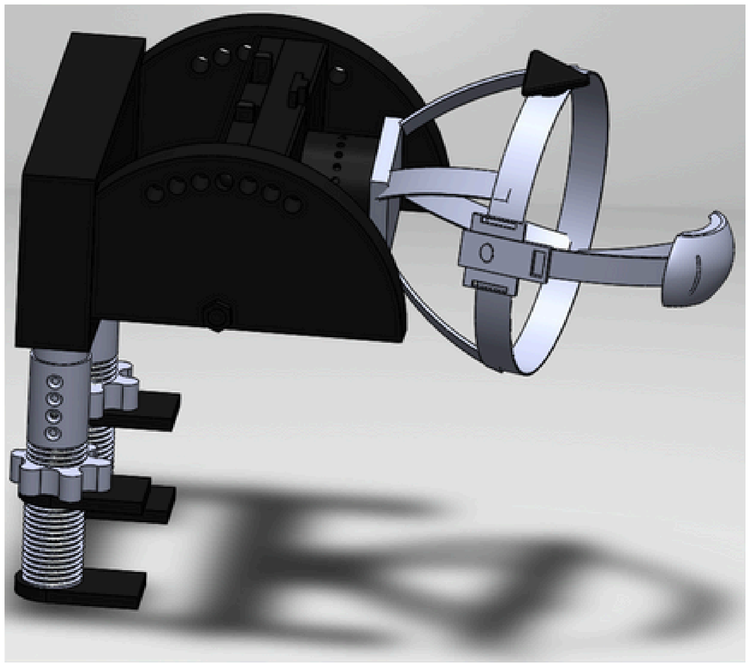
Faculty Mentor: Dr. Oleksii Shandra

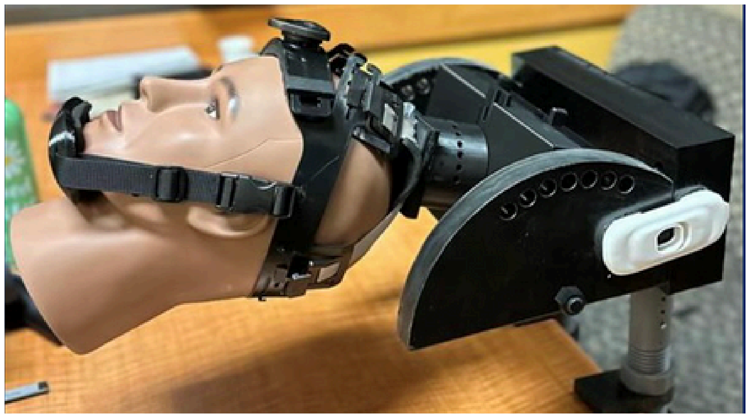
Project Sponsor:

Deinde Medical Corp.

*Marianne Porras, Asha Salas, Katrina Jabech, Frank Diaz

Each year approximately 795,000 Americans will experience a stroke, of which about 87% are ischemic strokes. For mechanical thrombectomy procedures, the mortality rate for strokes due to large vessel occlusions (LVO) remains high at 14.9%. Therefore, there is a critical clinical need to improve this endovascular procedure and reduce the incidence of serious complications. For instance, vessel perforation is the result of catheter interactions with the vasculature due to poor vessel visualization and patient movement. This complication highlights the need for head stabilization. Despite this, mechanical thrombectomy procedures currently utilize at most padding for patient head support, but no form of stabilization. The Deinde Head Stabilizer 2.0 acts as a noninvasive head stabilizer, preventing unintentional movement of the patient’s head when under conscious sedation without requiring invasive fixation techniques. It features precise, measurable head adjustment in three directions: flexion, extension and rotation, thereby offering physicians greater freedom in visualization of challenging vasculature. The device’s flexion and extension mechanism also provides patient comfort to individuals with spinal deformations such as kyphosis, thereby reducing patient irritability and reducing the likelihood movement. Having passed verification tests for head stabilization, static loading, emergency release, flexion extension and rotation to name a few, our device is the gold standard noninvasive head stabilization.





Team 8

Wireless, Low-Power Sleep Monitoring Device

Faculty Mentor: Dr. Sharan Ramaswamy

Project Sponsor:

BetaBlue

*Martin Fournillier, Layla Lopez, Christine Baker, Michelle Wiese

Disordered sleep affects up to 1/3 of the United States population and includes a plethora of illnesses that can have dramatic affects on the body. Some examples include insomnia, narcolepsy, and nocturnal epilepsy. These disorders can be discovered by monitoring electroencephalogram (EEG) readings during sleep. Current methods for monitoring sleep include both wired and wireless applications, both of which face challenges. Wired monitors are often bulky, restrictive, and can cause patient discomfort, which can affect patient quality of sleep. Wireless monitors face issues with power consumption and often cannot transmit data for a full 8 hours.

Our wireless, low-powered sleep monitoring cap is designed to provide a comfortable experience for patients and is capable of continuously monitoring and transmitting EEG signals for a full night of sleep. The low-powered circuit preserves battery life, while maintaining EEG quality. Gold-plated spike snap electrodes are used to adequately read the EEG signal through hair, and electrodes are insulated with silicone to limit noise. Thick neoprene fabric also contributes to noise reduction, as well as helping to provide adequate tension to hold the electrodes to the scalp.

Team 9

The Halo

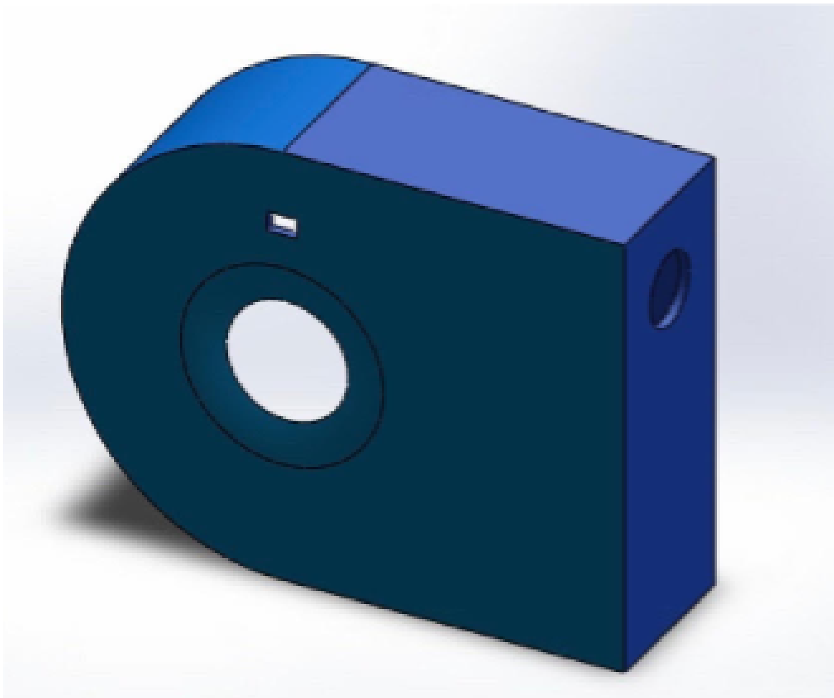
Faculty Mentor: Dr. Wei-Chiang Lin

Project Sponsor:

CNY Fertility

*Anna Paul, Arianna Filori, Andrea Sanabria, Mario Muxo

The Halo's final design features an intricately engineered lid, optimizing surgical visibility and instrument usability. At its core lies a spacious aperture tailored for versatile instrument accommodation, facilitating precise tool manipulation within the surgical cavity. Strategically enhancing structural integrity, a 3mm aperture on one side houses the camera, offering unobstructed surgical field views. An activation button on the opposite side initiates the 360-degree nano LED ring beneath the lid, ensuring uniform illumination and shadow elimination. This design epitomizes a holistic solution to laparoscopic myomectomy surgery challenges, prioritizing ergonomic principles for enhanced surgical efficiency.



Team 10

Flexible Remateable Interconnects (FRIs)

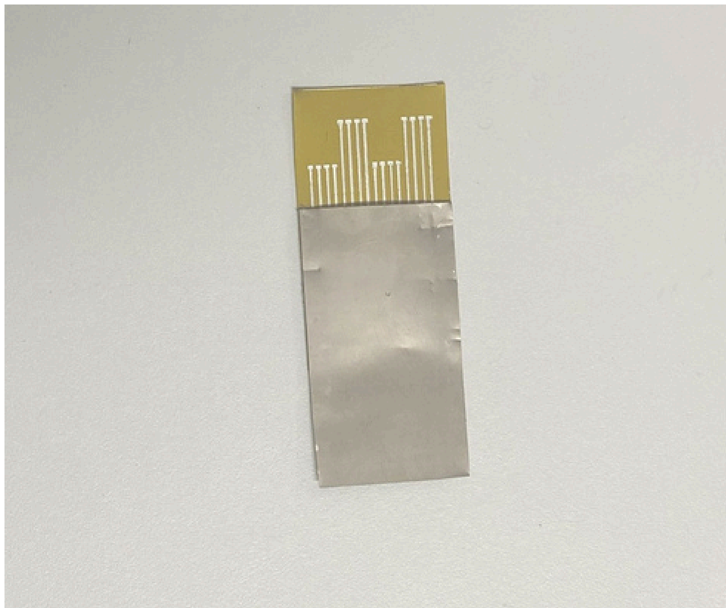
Faculty Mentor: Dr. Raj Pulugurtha

Project Sponsor:

JABIL

*Shanai Wilks, Yusra Jabeen, Jose Perez-Calderin

Connectors play an important role in the biomedical industry as they provide adaptable connectivity between underlying subsystems. Implantable neural systems such as deep brain stimulating systems (DBS) employ connectors between the neural electrode interface and the implantable pulse generator. Current modalities of connectors used employ an array of permanent chemical bonds to facilitate a high channel count, with the gold standard containing 4 channels, which increases the spatial resolution of the interface for various target tissues. The removal of these permanently bonded connectors cause considerable damage to befall surrounding tissues when the device requires extrication. Remateable connectors circumvent this issue by increasing the modularity of the biomedical system. Our design is flexible to minimize damage to surrounding tissues and to aid in overall body incorporation while maintaining a high channel count of 16 due to an area array design.



Team 11

Breathe EZ Retro Nasal Steam Inhaler

Faculty Mentor: Dr. Anthony McGoron

Project Sponsor:

advocare
ENT Specialty Center

Dr. Scott Schaffer

*Alicia Ramnauth, Mateo Fischer, Fabio Macias, Lorimar Santiago

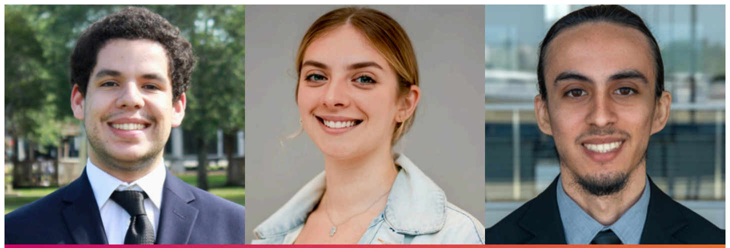
The common cold, influenza, Covid 19, and other respiratory illnesses affect millions of Americans every year. Patients experience symptoms like congestion, sore throat, coughing, sneezing, fever, and more. The viral load responsible for these illnesses accumulates in the nasopharynx. Current modalities on the market include nasal sprays, saline sprays, and nasal irrigation devices that are used to treat these illnesses and improve symptoms, but none of them reach the nasopharynx. On the other hand, retronasal steam inhalation has shown to reduce the accumulation of mucus and pathogens in the superior nose and nasopharynx. While there are aerosol-producing devices on the market such as nebulizers and facial steamers that can be used for inhalation, they are not fully portable. Our proposed solution is a portable retronasal inhalation device that produces water aerosol used for cleansing the nose and nasopharynx through the retronasal pathway. The novel device utilizes ultrasonic atomization technology to generate water aerosol and is powered by a rechargeable battery, giving users the convenience to charge the device as needed so that it can be used anywhere at any time.

Team 12

PHOED: Photonic Hemoglobin Oximetry Epidermal Device

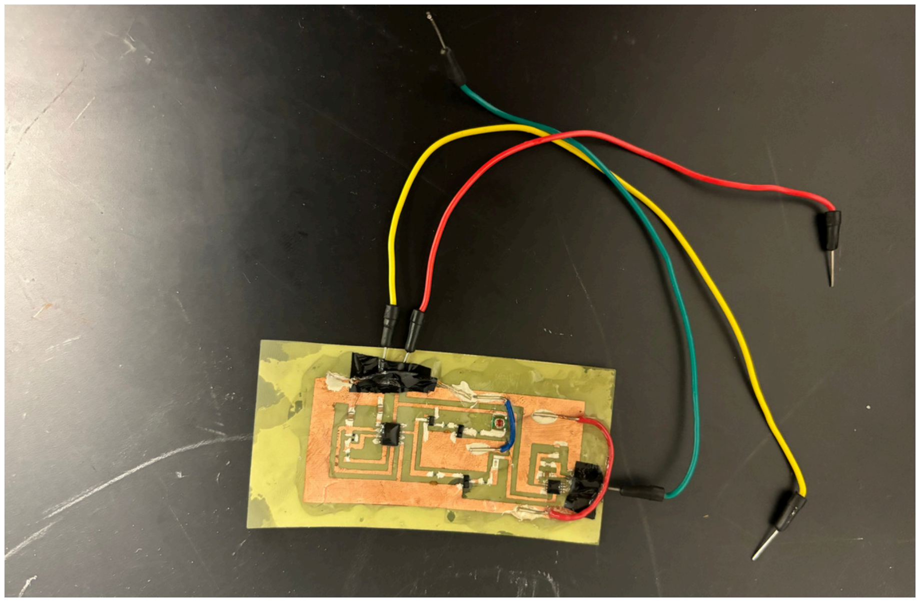
Faculty Mentor: Dr. Raj Pulugurtha

Project Sponsor:



*Ricardo Olivo, Maria Eduarda Vallilo, Peter Workman

Deep Vein Thrombosis (DVT) occurs when a blood clot forms in a deep vein of the leg, obstructing blood flow and impairing venous return, leading to post-thrombotic syndrome and Pulmonary Embolism. DVT represents a substantial health burden in the United States, as approximately 900,000 individuals per year (~2 in every 1,000 individuals) develop DVT leading to 100,000 deaths annually. Furthermore, around 30% of individuals diagnosed with DVT are at risk of having another episode. Unfortunately, current modalities are unable to continuously monitor blood flow, leading to a significant number of DVT cases going undiagnosed and untreated. To tackle this issue, this project proposes a noninvasive, fully functional stand-alone BioPhotonics patch designed to continuously monitor tissue oxygenation levels in one or more of the deep veins of the leg. By integrating the modified Beer-Lambert law for blood flow, creating a more complex circuit to reduce signal noise and light source interference in the photodetector, and creating a 3-D phantom model to mimic specific anatomical and physiological properties of the leg, the device utilizes hemoglobin oxygenation as a biomarker for early detec tion of blood flow abnormalities. Using the method of continuous monitoring, this project would help reduce DVT associated morbidity and mortality.



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Project Judges

On behalf of the entire Biomedical Engineering staff, we'd like to thank our judges for their dedication and skill when it came to the judging of our Senior Design Expo and Competition oral and poster presentations. It is thanks to your generosity, knowledge and patience that this celebration of our students' efforts has been immensely successful.

To Our Dedicated and Distinguished Faculty


Michael Brown, M.D., Ph.D.


Michael Christie, Ph.D.


Anuradha Godavarty, Ph.D.


Joshua Hutcheson, Ph.D.


Shuliang Jiao, Ph.D.


Wei-Chiang Lin, Ph.D.


Anthony McGoron, Ph.D.


Hamid Shahrestani


Sharan Ramaswamy, Ph.D.


Jessica Ramella-Roman, Ph.D.


Jorge Riera, Ph.D.


Nikolaos Tsoukias, Ph.D.


Anamika Prasad, Ph.D.


Oleksii Shandra, Ph.D.


Raj Pulugurtha, Ph.D.

This academic event is made possible by the generous support of the Wallace H. Coulter Foundation. To learn more about the Wallace H. Coulter Foundation, please visit whcf.org.

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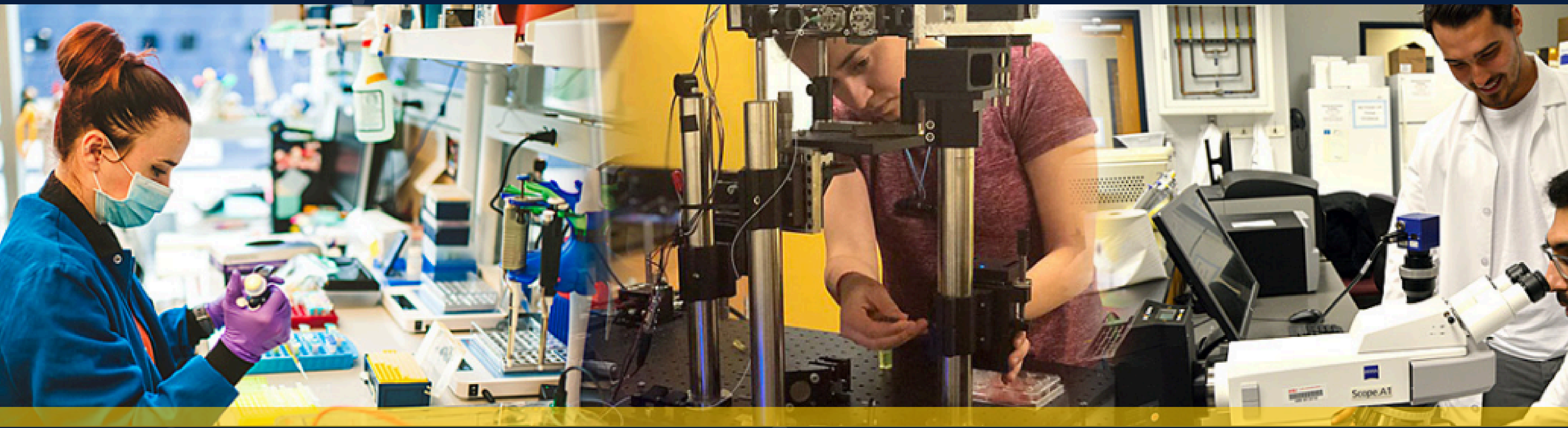

FIU | Engineering & Computing

Department of Biomedical Engineering

The Department of Biomedical Engineering at Florida International University (FIU) located in Miami is committed to preparing ambitious students who want to combine their love of problem-solving with their desire to help others through this fascinating growing field that applies cutting-edge technologies and modern engineering techniques to improve healthcare.

bme.fiu.edu

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Department of Biomedical Engineering

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