FIU | Engineering & Computing

Biomedical Engineering

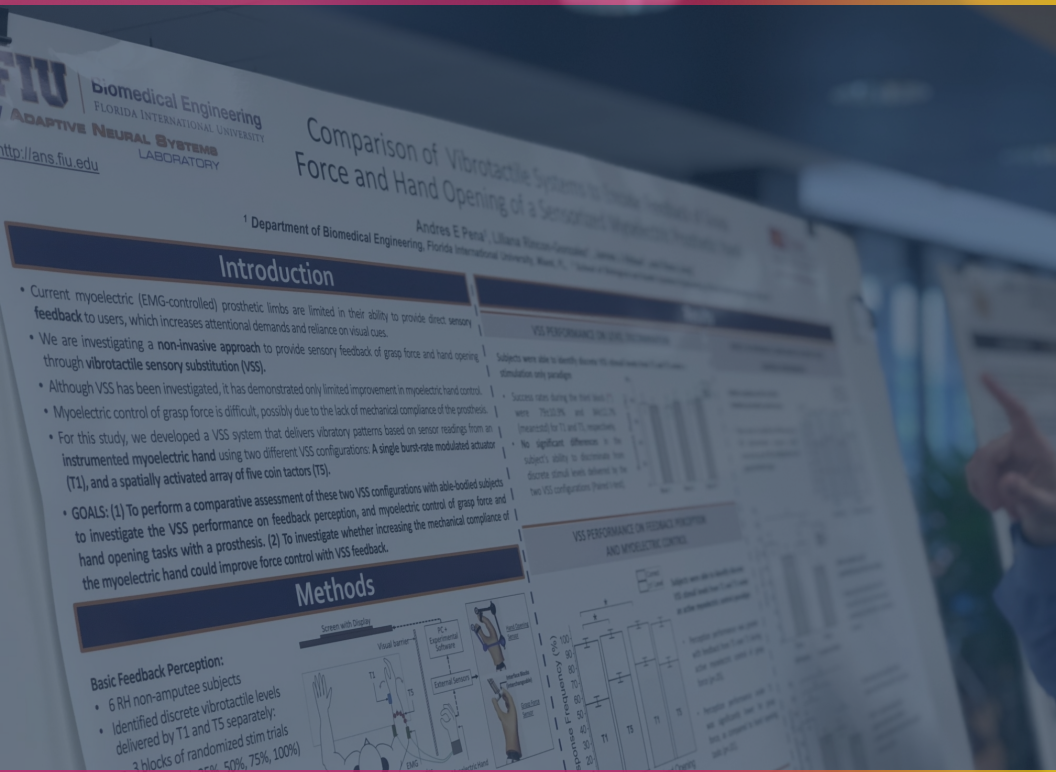
BIOMEDICAL ENGINEERING SENIOR design expo

FALL 2021

AN UNDERGRADUATE STUDENT PROJECT SHOWCASE & COMPETITION

DISCOVER | DESIGN | DEVELOP | DELIVER

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



BIOMEDICAL ENGINEERING

Senior Design **Project Expo**

Thursday, December 2, 2021

The Biomedical Engineering Senior Design Expo & Competition is the culminating experience for undergraduates in Biomedical Engineering. Teams of students present their capstone projects, showcasing prototypes of medical devices, biomedical processes, or software systems solutions that address unmet biomedical needs.

FIU Engineering & Computing
Biomedical Engineering

Congratulations Seniors!

Ranu Jung
Wallace H. Coulter Eminent Scholar Chair in Biomedical Engineering, Professor and 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.

Dr. Ranu Jung

FIU | Engineering & Computing

Biomedical Engineering

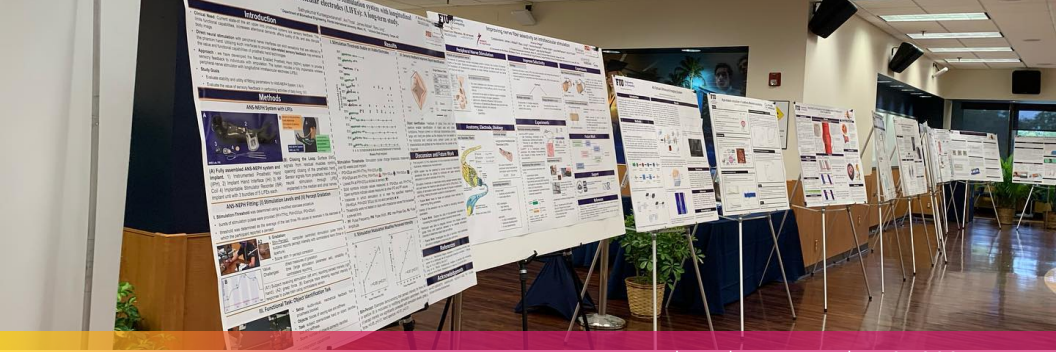
ABOUT OUR

Biomedical Engineering Program

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.

Our Biomedical Engineer department is ranked #1 for bachelor's degrees awarded to Hispanics and #6 for bachelor's degrees awarded to African Americans. Nationally, we are among the Top 20 to offer BS degrees, Top 65 for research expenditures, and considered in the Top 30 of the most popular in the country*. Florida International University is designated a Carnegie Highest Research (R1) and Carnegie Community Engaged Institution.

*ASEE 2019, NSF HERD 2018, and College Factual 2020



Thursday, December 2, 2021

AGENDA

Room EC 2300

7:30am – Breakfast

8:30am – 8:45am

Introduction & Orientation –

Dr. Michael Christie, Associate Teaching Professor

Welcome Remarks from

Dr. Ranu Jung, Chair and Professor of Biomedical Engineering

Introduction & Instructions to judges

8:45am – Team 1: P.R.O. Scan

9:00am – Team 2: RestoreVS

9:15am – Team 3: Walking Assist Hip Device

9:30am – Team 4: ProphyLD

9:45am – Team 5: Ampoule Scoring and Sealing Machine

10:00am – Team 6: Secure Extra Adipose Tissue (S.E.A.T)

10:15am – Team 7: 3D CPM Device to Restore Elbow Mobility

10:30am – Team 8: Acetabular Cup Implant Adaptation

10:45am – Team 9: Fibulock System Attachment for Wire Placement

Panther Pit

11:30am – 1:00pm Poster Presentation & Competition

1:00pm – 2:00pm Lunch

Room EC 2300

2:00pm – 2:15pm

Awards Ceremony with Dr. Godavarty, Dr. Jung, and Dr. Christie

Word of Thanks by Dr. Godavarty

Presentation of Awards

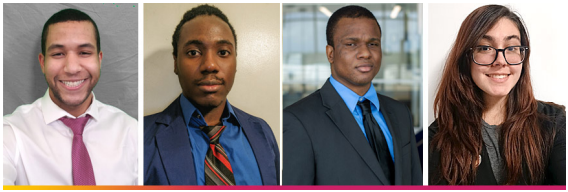
Concluding Remarks by Dr. Jung

Team 1

P.R.O. Scan

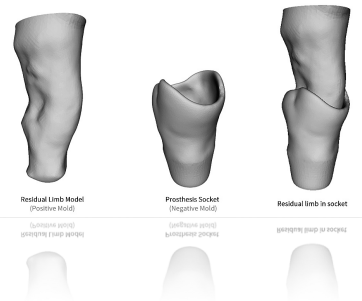
Faculty Advisor: Professor Shuliang Jiao
Company Sponsor:

Bio Engineering Labs, Corp.
NEO TECHNOLOGY



Lyan Basora Dorville, Xaundrae Edwards, Nedge Joseph, Sofia Villena

Prosthesis sockets are primarily constructed by plaster-casting a patient's residual limb, which may cause skin irritation from contact with plaster and fatigue from lengthy mold-setting time. 3D-scanners can also model residual limbs with improved accuracy, but current scanning options on the market are costly and not specifically designed for prosthetic applications. Our project was to develop a method to capture the contours of residual limbs in a cost-effective and time-efficient manner to facilitate socket creation. We proposed a cost-effective device that could contactlessly 3D-scan transradial and transtibial residual limbs with 95% accuracy under 2 minutes. The selected design consists of motor-driven, 3D-printed polylactic acid rotating rings to which two depth-sensing cameras are mounted. The cameras are rotated 360 degrees about a patient's residual limb to capture and generate a 3D point cloud of the limb; the data is then processed into a 3D model which gives prosthetists another method for rectification and 3D printing options for the patient's socket. The safety of the device was verified through simulated structural and fatigue analyses, confirming that key components of the device had safety factors greater than 1.2. Protocols assessing the device's scanning time and accuracy in scanning simple geometries were also carried out for the purpose of device verification. Ultimately, the team successfully created a device with $630.69 that can scan a patient's residual limb within 15 seconds, but future work to increase the accuracy and comfort of using the device can be conducted to improve the design.



FIU Engineering & Computing
Biomedical Engineering

Team 2

RestoreVS

Faculty Advisor: Professor Jorge Riera
Company Sponsor:

BetaBlue

Paula de la Plaza, Osmaro Exposito, Carolina Mourelo Goni, Nicolas Valencia-Diaz

Schizophrenia affects around 20 million people worldwide. Treatments involve the use of pharmaceuticals that provoke side effects (such as uncontrollable movements and weight gain) and, approximately, 30% of patients are treatment-resistant. Another treatment option is invasive stimulation therapies. These treatments do not reach a desirable rate of efficacy in treating positive symptoms. Additionally, these treatments are often very expensive, which brings a financial burden onto the patients. Furthermore, there is a lack of innovation and research on newer pharmaceuticals in need of reducing treatment costs.

Our proposed solution is to build a cost-accessible non-invasive, wearable device that operates as an interferential stimulator that will target the Vagus nerve. Such a device will output controlled electrical signals that reach the Vagus nerve, through 2 pairs of electrodes placed at the upper left quadrant of the abdomen and upper thoracic region of the back respectively. The frequency will be controlled from a graphical user interface (GUI) by a healthcare provider. The goal of these signals is to normalize the activity of dopamine, which is the hormone that promotes the positive symptoms presented in schizophrenia, as well as controlling neuroplasticity and synaptic interactions while also restoring normal hippocampal function.

Team 3

Walking Assist Hip Device

Faculty Advisor: Professor Wei-Chiang Lin
Company Sponsor:

Bio Engineering Labs, Corp.
NEO TECHNOLOGY

Blanka Alonso, Erick Cruz, Anali Iglesias Gonzalez, Kelly Nair Rojas

Loss of body movement control in one side of the body (known as hemiparesis), is often caused by post-stroke brain damage, a condition affecting ~800,000 people annually in the United States. A decrease of blood flow in the brain's cerebellum area limits the nourishment of nutrients to the neurons, causing their death. The biomedical need of this project lies in the lack of functionality of the hip muscles, leading to unbalanced and uncoordinated movements. Information received by the brain and spinal cord is not transmitted properly throughout the peripheral nervous system, which connects to different muscles, including those in the hip joints. This lack of functionality or control of the hip muscles limits the patient's independence and could cause medical emergencies like falling.

Physical or occupational therapy, and medications are a significant part of the hemiparesis treatment. Additionally, commercially available walking assist devices, like walkers and wheelchairs, can make patients more independent, but they do not contribute to muscular recovery. Our plan is to help hemiparesis patients regain hip functionality by creating an affordable (active and passive) hip device (15 lb. or lighter) (Bing Chen, 2020) that assists in equilibrium and motor function recovery, improving their quality of life.

Team 4

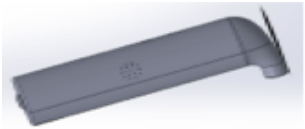
ProphyLD

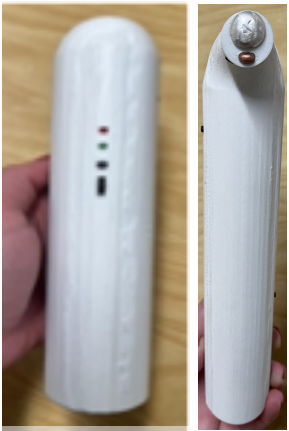
Faculty Advisor: Professor Joshua Hutcheson
Company Sponsor:

activoris
Medtech. Pharma. Food.

Ricardo Cabezas, Anastasiya Drandarov, Carolina Guillen, Daniel Peno, Alexander Trinidad

Lyme disease is caused by Borrelia burgdorferi s.l. bacteria, which are transferred from blacklegged ticks to the human dermis when the ticks feed on a human host. Over 300,000 cases in the United States and about 85,000 cases in Europe are reported annually, with common symptoms including fever, arthralgia, musculoskeletal pain, fatigue, and carditis and facial palsy in more advanced cases. The only available treatment against Lyme disease is a course of antibiotics that can take up to four weeks to complete, and 10% of patients report persistent symptoms that last up to ten years. There are no vaccines or medtech available on the market to prevent this bacterial infection. Our proposed solution (ProphyLD) provides a prophylactic therapy by delivering an effective and safe dose of silver ions to the dermis in less than 30 minutes. The device offers the advantage of being handheld so it can be carried by outdoor hobbyists to areas where the ticks inhabit, and it houses a tick removal tool in case the tick is found still attached to the skin. Furthermore, it offers visual and acoustic guidance to the user to avoid undertreatment.





Team 5

Ampoule Scoring and Sealing Machine

Faculty Advisor: Professor Anthony McGoron
Company Sponsor:

PANTHER BIOMEDICAL
Medical Packaging Solutions

Elizabeth Cheng, Ana Veruska Guerrero, Jesus Alvarado, Maria Salome, Gisela Lopez

Medical ampoules are used for packaging of pharmaceutical drugs. This machine is meant to score and tip a vacuum sealed ampoule, whose purpose is to collect a liquid sample for diagnostic purposes. Most ampoule assemblies are large scale automated processes that cater to specific sized ampoules. By utilizing skills learned from BME courses and SolidWorks, we were able to create an automated machine that can score an ampoule at a specific height and seal the tip using a polyolefin material to avoid glass hazards for the users. The Ampoule Scoring and Sealing machine is broken down into four stations– automatic loading and unloading, scoring, tipping, and heating. The machine is composed of multiple servo, and stepper motors that work in conjunction with linear actuators to perform the functions outlined. The whole operation is controlled via multiple MEGA Arduino boards with Bluetooth connection from a phone app. Verification tests verified the efficiency and efficacy of our machine. Applications of this machine can be in the medical field where ampoules can be used to finish the manufacturing process to ready them for packaging.

FIU Engineering & Computing
Biomedical Engineering

Team 6

Secure Extra Adipose Tissue (S.E.A.T)

Faculty Advisor: Professor Zachary Danziger
Company Sponsor:

TAG3 bottom line medtech™

Ligia Camilla Araque, Samuel Elgueta, Schneider Jean, Domenica Passariello, Daniella Zecchino

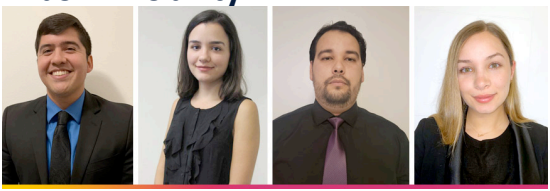
The ever-growing morbidly obese population, with a 42.4% prevalence between 2017 and 2018, has caused an increase in treatment for obesity-related complications such as ventral hernias provokes an overhanging abdominal layer of subcutaneous fat. Our intention is to aid the medical staff during TAVR, C-section, and laparoscopic surgeries, amongst others in exposing the pelvic area that is covered by the overhanging abdominal layer. Consequently, we have designed a surgical retractor S.E.A.T., Secure Extra Adipose Tissue, intended for pre-operative procedures bespoke to the patient's physiology. As we increase visibility and expose the pelvic area, from the lower abdomen to the groin area, our medical device has the objective to displace extra adipose tissue without causing respiratory problems pre-operatively and during operative procedures, while also avoiding skin irritation and allowing compatibility to different body shapes. Our result is a device, that consists of fabric materials as the interface and an anchor system to the operating bed that can all together withstand a panniculus of a mass of 60 lbs, without causing any adverse effects on the skin and respiratory system. Thus, fulfilling the patient's and medical staff's needs.

Team 7

3D CPM Device to Restore Elbow Mobility

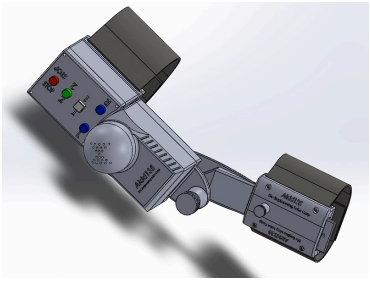
Faculty Advisor: Professor James Schummers
Company Sponsor:

Bio Engineering Labs, Corp.
NEO TECHNOLOGY



David Barboza, Isabella Davila, Armando Hernandez, Daniela Polo

Hemiplegia is paralysis that affects movement on one side of the body. The most common type of hemiplegia occurs after a stroke. 9 out of 10 stroke survivors have some degree of paralysis, affecting patients' lifestyles and sense of independence. Hemiplegia can be treated with physical therapy, which aims to improve function by promoting reactivation of existing nerve connections and developing new ones. However, patient compliance with physical therapy is low due to high costs and limited access. The proposed solution is to create a continuous passive motion device that provides at-home therapy for people with hemiplegia of the elbow post- stroke. Earlier intervention following a stroke not only improves function and increases the chances of recovery, but also reduces the need for prolonged sessions with physical therapists and recurrent visits to clinics. AIdd135 provides continuous passive motion therapy exercise to both arms with ranges of motion of 115° or 58°, with a constant speed of 50°/sec. Verification testing supports that the device has a factor of safety of 3 and yields muscle stimulation with safe therapeutic movements. Summarily, AIdd135 provides patients with a rehabilitation option that can meet their needs from home.



FIU Engineering & Computing
Biomedical Engineering

Team 8

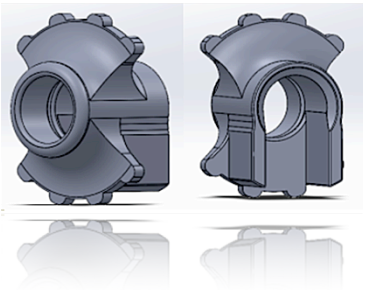
Acetabular Cup Implant Adaptation

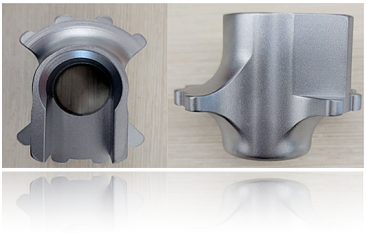
Faculty Advisor: Professor Raj Pulugurtha
Company Sponsor:

Exactech®
Surgeon focused. Patient driven.™

Laeticia Fonhoue Bogne, Eddy Calero, Samer Nasr, Loraine Sierra

Over 400,000 patients require total hip arthroplasty (THA) per year. Total hip arthroplasty is a surgery in which the patient's acetabular cup and femoral head are replaced with implants. The success of the surgery is reliant on the angle at which the acetabular cup implant is placed. The implant is embedded in the acetabulum using a cup impactor. Five percent of THA encounters a complication in which the impactor detaches from the cup implant unexpectedly. This causes an elongation in operation time, which in turn causes the patient to be subjected to anesthetics for a longer period. It was found that for every thirty minutes an operation is extended, the risk factors for pneumonia, bleeding, and infection increase by 14%. The project scope is to create an adapter for the acetabular cup impactor that provides greater rotational and torsional control when attached to the cup implant during surgical procedures. The design solution selected is a stainless steel part with two solid wings encasing the tip of the offset impactor. To reduce the risk of disengagement and evenly distribute the forces applied onto the cup, each wing has four projections that mate with the scallops found on the cup's rim. Testing shows that the new design is an improvement compared to the previous impactor model.





Team 9

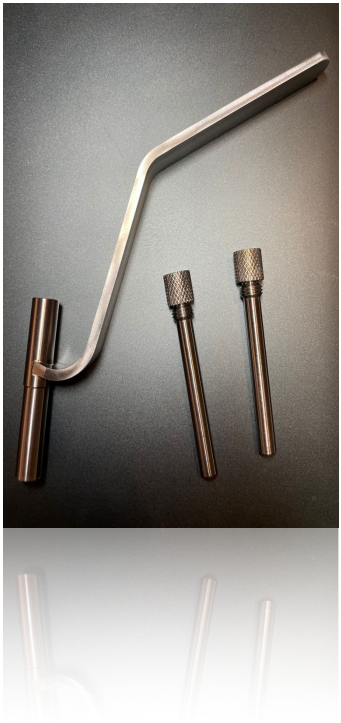
Fibulock® Guide for Wire

Faculty Advisor: Professor Nikolaos Tsoukias
Company Sponsor:

Arthrex®
Helping Surgeons Treat Their Patients Better

Pedro Alcolea, Paulina Alvarez, Elainy Ruiz, Anet Sanchez

The Fibulock Fibular Nail® presents the most cutting-edge technology to treat people with fibula fractures with less invasive treatment. During fibular nail surgery, the correct placement of the nail relies almost entirely on the k-wire insertion. 7 out of 10 surgeons place the k-wire too medially or too laterally, which can result in fracture of the bone cortex when drilling. As the initial placement of the k-wire is usually based on insertion trial-and-error, this time-consuming step regularly increases operation time and decreases the accuracy and efficiency of the procedure. No tools have been unanimously adopted by surgeons, resulting in manual insertion during surgery, which is subject to human error.



Arthrex must develop a Fibulock Fibular Nail® guide that guarantees correct initial and trajectory without relying on incorrect initial insertion to increase accuracy and ease of use. Differentiating themselves from similar intramedullary fibular nail packages would result in higher surgeon satisfaction, as it would represent the first effective k-wire guide in the market.

Consequently, Arthrex has tasked our group to fix the problem by creating a physical guide to ensure the k-wire is placed within the right entry point and follows the intended trajectory consistently. This physical guide was completed by December of 2021.

Project Sponsors

Arthrex® Helping Surgeons Treat Their Patients Better

Exactech® Surgeon focused. Patient driven.™

BetaBlue

activoris Medtech. Pharma. Food.

Bio Engineering Labs, Corp. NEO TECHNOLOGY

TAG3 bottom line medtech™

PANTHER BIOMEDICAL Medical Packaging Solutions

Senior Design Project – Instructors

Michael C. Christie

Hamid Shahrestani

Senior Design Project – Faculty Mentors

Zachary Danziger

Joshua Hutcheson

Shuliang Jiao

Wei-Chiang Lin

Anthony McGoron

Raj Pulugurtha

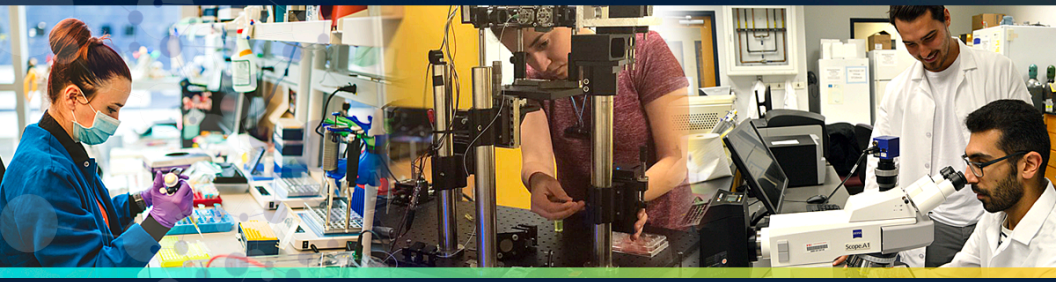
Yun Qian

Jorge Riera

James Schummers

Nikolaos Tsoukias

DREAM, DISCOVER, INSPIRE, INNOVATE



FIU | Engineering & Computing

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

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

Florida International University | College of Engineering & Computing

Department of Biomedical Engineering

10555 West Flagler Street Suite EC 2600 Miami, FL 33174