Spring 2016

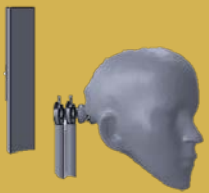
Discover Design Develop Deliver

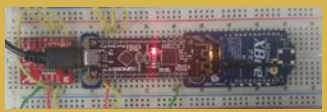
Senior Design Projects

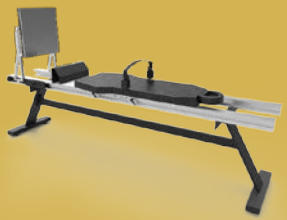
Biomedical Engineering Technology Expo and Competition

Friday, April 29, 2016
8:00 a.m. – 5:00 p.m.
FIU Engineering Center

FIU Biomedical Engineering
Florida International University







DISCOVER DESIGN DEVELOP DELIVER

SENIOR DESIGN PROJECT AGENDA

8:00am Breakfast

8:40am Welcome by Dr. Wei-Chiang Lin, BME Interim Chair and Associate Professor

8:50am Introduction and Orientation by Dr. Anthony McGoron, Associate Dean of Academic Affairs and BME Professor

9:00am Team 1: Prefabricated Prosthetic Cover for Transtibial Prostheses
Sponsor: Garrison's Prosthetic Services

9:30am Team 2: Miniature EEG/NIRS Device for Stimulus-Driven Localized Brain Imaging
Sponsor: FIU Biomedical Engineering

10:00am Team 3: Pressure-Standardized Soft Tissue Measuring Tool
Sponsor: Arthur Finnieston Prosthetics + Orthotics

10:30am Team 4: Optimization of Hollow Tube Geometry of Intravenous Valve
Sponsor: DDE Lab Inc.

11:00am Team 5: Lower Limb Closed-Chain Strength Assessment Device
Sponsor: FIU Nicole Wertheim College of Nursing & Health Science

11:30pm Team 6: Wireless Trans-Tibial Prosthetic Foot Alignment Tool: Vertical Adjustment
Sponsor: Garrison's Prosthetic Services

DISCOVER DESIGN DEVELOP DELIVER

SENIOR DESIGN PROJECT AGENDA

12:00pm Team 7: System of Sensors for Gait Analysis
Sponsor: FIU Nicole Wertheim College of Nursing & Health Science

12:30pm Lunch Break

1:00pm Team 8: Automated Islet Sampling System – 2nd Generation
Sponsor: Biorep Technologies

1:30pm Team 9: Nutec Heating and Imaging Device
Sponsor: Entopsis

2:00pm Team 10: Direct Ophthalmoscopy Simulation System
Sponsor: FIU STAR Center

2:30pm Team 11: Optimizing Tubing and Housing of Peristaltic Pump System for Drug Reconstitution
Sponsor: SHL PHARMA

3:00pm Team 12: Bio Impedance Sensor
Sponsor: Gamechangertec

3:30pm Team 13: Lumbar Puncture Simulator
Sponsor: FIU STAR Center

4:00pm Judges Deliberations

4:30pm Senior Design Award Ceremony and Reception

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Message from the Chair

Congratulations Seniors!

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.

Wei-Chiang Lin
April 2016

Prefabricated Prosthetic Cover for Transtibial Prostheses

Team 1: Kali Chiapetta, Byron Coker, Davion Harrison, Jingwen Wu
Faculty Advisor: Dr. Jacob McPherson
Company Sponsor: Garrison's Prosthetic Services

Kali Chiapetta

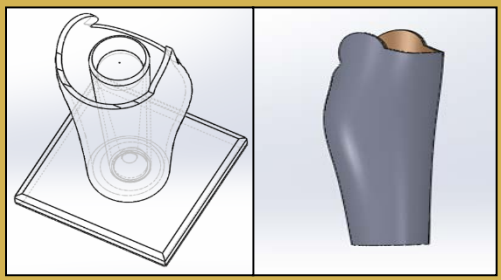
Byron Coker

Davion Harrison

Jingwen Wu

Abstract

Prosthetic covers are commonly utilized in the final delivery of a prosthetic device to a patient. The purpose of the cover is to protect and support the underlying components of the prosthetic while also providing a realistic appearance. The current approach to developing a transtibial prosthetic cover is to sculpt a foam block of uniform dimensions into an anthropomorphically realistic limb segment for each patient. This process results in material loss and is highly time consuming, both of which lead to increased costs. To mitigate these issues, we are developing a prosthetic cover based on a 3-D printed negative mold of a standardized transtibial limb segment. Liquid foam is poured into the negative mold to rapidly achieve the final prosthetic cover. This process substantially improves upon the current methodology by reducing material loss and increasing overall efficiency, resulting in a prefabricated, realistic transtibial cover that can easily be scaled to different socket sizes.



Negative mold Prosthetic Cover

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RESTORING BALANCE RENEWING HOPE

FIU Biomedical Engineering
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Miniature EEG/NIRS Device for Stimulus-Driven Localized Brain Imaging

Team #2: Somafa Bailey, Kevin Leiva, Andres Lopez,
Carolina Moncion, Jonathan Rolon
Faculty Advisor: Dr. Jorge Riera & Dr. Anuradha Godavarty
FIU Biomedical Engineering Dept.

Somafa Bailey

Kevin Leiva

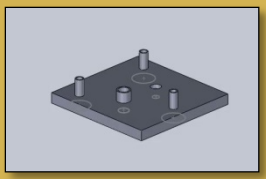
Andres Lopez

Carolina Moncion

Jonathan Rolon

Abstract

Electroencephalography (EEG) is used for monitoring electrical activity in the brain and Near-Infrared Spectroscopy (NIRS) can be utilized to detect changes in blood flow. However, they are typically used independently. The objective is to develop a device capable of simultaneously collecting both sets of data because by synchronizing these two modalities, it is possible to analyze the relationship between changes in localized brain electrical activity and the corresponding blood flow or Neurovascular Coupling (NVC). This will be accomplished by incorporating a time stamp when each data point is collected in order to make sure that both modalities are recording at the same time. The prototype will be tested for synchronization with careful consideration being taken to maintain any delay between the two sets of data in the milliseconds range. In the future, this device will be used to study NVC as it relates to different neurological disorders, mainly Alzheimer's.



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Pressure-Standardized Soft Tissue Measuring Tool

Team #3: Caroline Betances, Andrea Charara, Ariel Ruiz
Faculty Advisor: Dr. Anthony McGoron
Company Sponsor: Arthur Finnieston Biosculptor Corporation

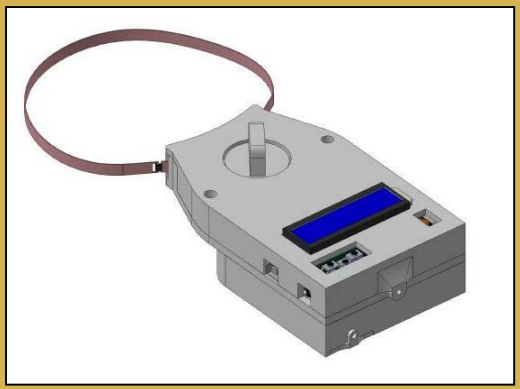
Caroline Betances

Andrea Charara

Ariel Ruiz

Abstract

Proper limb measurement is a vital component of the prosthetic fitting process. Current measuring methods lead to inaccurate and unrepeatable measurements which could result in an ill-fitting prosthetic causing patient discomfort and the possibility of abandonment of the prosthesis. This device serves as a tool to not only take correct circumferential measurements but also standardize the fitting process by allowing the prosthetists to observe how much pressure is being applied on the skin by measuring the tension on the tape. The tool uses a microcontroller to track the displacement and tension of the tape while displaying the values on a screen.



ARTHUR FINNIESTON
PROSTHETICS + ORTHOTICS

FIU Biomedical Engineering
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Optimization of Hollow Tube Geometry of Intravenous Valve

Team 4: Artem Arvanitidis, Anthony Higgins, Maria Montoya, Tuyet Pham and Danique Stewart
Faculty Advisor: Dr. Sharan Ramaswamy
Company Sponsor: DDE Lab, Inc.


Artem Arvanitidis


Anthony Higgins

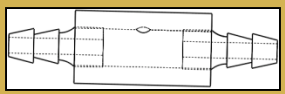

Maria Montoya


Tuyet Pham


Danique Stewart

Abstract

Intravenous access devices (IVADs) provide vascular access for blood withdrawal and delivery of medications. However, current complications involve formation of clots and infection due to insertion, immune response and care after insertion. The intravenous valve is a unique subcomponent of a novel IVAD developed by DDE Lab, Inc. This device aims to reduce IVAD thrombosis compared to current modalities through enhanced blood flow. The objective of the senior design project was to (1) optimize the aspect ratio and middle housing angle of the intravenous valve in order to enhance flow dynamics by minimizing stagnation and (2) miniaturize the device to accommodate a rat model. The miniaturized prototype of the original served as the control and the modified versions were compared against the control from computational and experimental flow studies. Objective (1) was verified through performing platelet adhesion assessment on the prototypes and objective (2) was verified by scaling the optimized device configuration to the rat model. Through these studies, we hope to assist DDE Lab, Inc. in improving blood flow characteristics through the tubular component of their IVAD.



Biomedical Engineering
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Lower Limb Closed-Chain Strength Assessment Device

Team # 5: Carnie Lazarre, Angia Saez, Luciano Aguirre, Erick Amador & Akil Shabazz
Faculty Advisor: Dr. Laura McPherson
Company Sponsor: Dr. Mark Rossi

Abstract

The Lower Limb Closed Chain Strength Assessment device is a clinical tool that measures the functional strength of the entire lower limb at multiple knee angles. Most activities of daily living (i.e sit-to-stand, walk, and stairs) which are the primary focus of early physical therapy interventions, require the coordinate use of multiple joints and are closed-chain. However, current modalities measure joint strength in isolation and in a setup where the distal segment is free to move (open-chain).The proposed device provides high resolution, objective measurements that aid in quantifying progress in closed-chain multi-joint force output for patients who have undergone total knee replacement surgery. With approximately 700,000 total knee replacement annually, there is a high demand for an objective functional strength assessment device. The device uses an automated user friendly software, requires minimal setup time and is affordable for clinical uses. The features are opted with a mechanism that allows modification to accommodate other patient populations.


Carnie Lazarre


Luciano Aguirre


Erick Amador


Angia Saez


Akil Shabazz

FIU Nicole Wertheim College of Nursing & Health Sciences
Florida International University

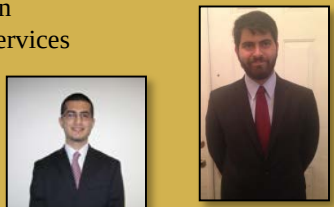
FIU Biomedical Engineering
Florida International University

Wireless Trans-Tibial Prosthetic Foot Alignment Tool: Vertical Adjustment

Team #6: Tommaso Benigni, Sophia Boucher, Elizabeth Gallardo, Luai Mustafa, Melissa Peña
Faculty Advisor: Dr. Jacob McPherson
Company Sponsor: Garrison's Prosthetic Services

Abstract

The orthotic/prosthetic community has seen steady, continual growth since the year 2008. This increase has led to a demand for biomedical products that improve the efficiency of prosthetic practitioners. One specific challenge that prosthetists face today is the process of properly aligning trans-tibial prosthetics for amputees. Currently the only method that is being employed to complete this task is entirely manual, placing a physical burden on prosthetists. Furthermore, it relies on the skilled eye of the practitioner. Due to these shortcomings of the current method, our project is aimed towards developing a remotely-controlled method of aligning the vertical length of the pylon for trans-tibial prosthetics. This device will eliminate the need for prosthetists to exert physically demanding means to align prosthetics and will deliver repeatability, objectivity and efficiency to the alignment process. This tool will be the first step towards the development of a fully-automated method for trans-tibial prosthetic alignment.



Tommaso Benigni

Luai Mustafa

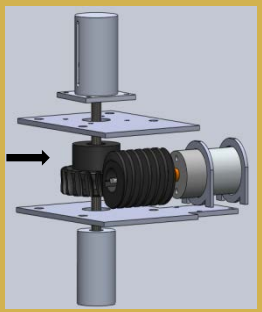
Sophia Boucher

Melissa Peña

Elizabeth Gallardo

Pylon →

Design for automating vertical adjustment →



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System of Sensors for Gait Analysis

Team #7: Michel Alonso, Christopher Chow, Carlos Camargo, Jessyka Desrosiers and Kishmere Rolle
Faculty Advisor: Dr. Michael Christie
Company Sponsor: FIU Physical Therapy Department (Dr. Leonard Elbaum)

Abstract

Gait analysis is the study of human locomotion. This method of analysis is essential for the detection of biomechanical abnormalities, determining the suitable treatment methods and as means of monitoring the effectiveness of treatment interventions. Musculoskeletal conditions, neurological diseases and injuries and aging can affect gait. These conditions include, Parkinson's disease, polio, arthritis, cerebral palsy, etc. Pathological gait is detected using two types of technologies, wearable sensor and non-wearable sensor system. These technologies are either often expensive, or not suitable for high volumes of patients. The team has developed a low cost integrated system of inertial measurement units, Arduino microcontrollers, and Xbee wireless transmitters with programming code to allow a clinician to calculate a patient's stride length, swing time, stance time, and cadence. The system will provide a user friendly interface, a wide communication range and affordable high performance.

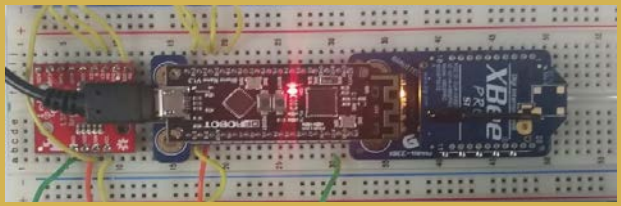
Michel Alonso

Christopher Chow

Jessyka Desrosiers

Kishmere Rolle

Carlos Carmago



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Automated Islet Sampling System – 2nd Generation

Team 8: Aaron Adderley. Brian Castillo, Jiali Lei, Jose Rondon
Faculty Advisor: Dr. Wei-Chiang Lin
Company Sponsor: Biorep Technologies, Inc.


Aaron Adderley


Brian Castillo

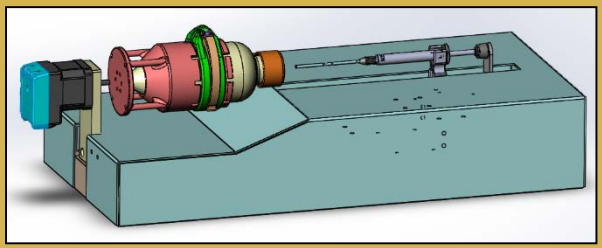

Jiali Lei


Jose Rondon

Abstract

Every six seconds a person dies from diabetes and the cost of diabetes treatment is projected to be $627 billion by the year of 2035. Islet transplantation is a minimally invasive procedure for treating type 1 diabetic patients currently undergoing clinical trials, which involves feeding the islet cells through a catheter into the hepatic portal vein. One of the critical success factors in islet transplantation is providing sufficient islet mass. Current procedures of islet preparation for transplantation consists of pancreatic tissue perfusion, islet isolation, islet purification, and islet perifusion.

Our project focuses on the sampling process after islet isolation, which is a time-sensitive procedure. The current sampling method at the University of Miami's Diabetes Research Institute involves manual handling that introduces variability across other research facilities and institutes. This project comprises of a newly modified system, which improves upon the 1st-Gen Islet Cell Sampling System. It aims to automate the islet sampling process and create homogenous islet solutions. The 2nd–Gen Islet Sampling System will provide consistent and accurate islet counts by standardizing and automating the sampling process.



Biorep® Technologies

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Nutec Heating and Imaging Device

Team #9: Yaseen Ali, Morais Brown, Carlo Emiliani, Salease Randolph
Faculty Advisor: Dr. Wei-Chiang Lin
Company Sponsor: Entopsis

Yaseen Ali

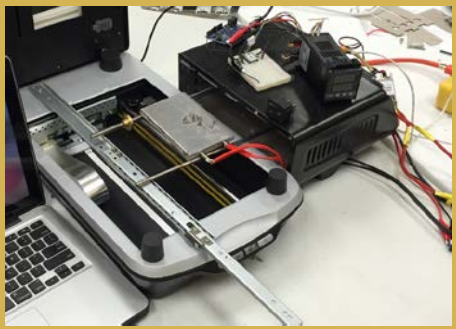
Morais Brown

Carlo Emiliani

Salease Randolph

Abstract

Current diagnostic tests in clinical settings require multiple inefficient procedures with high costs. There is also a lack of access to efficient diagnostic techniques in less developed countries. The Nutec platform is a universal diagnostic platform that applies a collected sample to the device that will be heated to detect a bio-signature to be scanned and upload into the cloud system. The end result is an inexpensive cross reference analysis to produce a diagnosis of the user. The aim of the project was to design and evaluate the imaging and heating components. The heating device was to withstand a high amount of temperature to produce the signature on the Nutec slide and the imager was to produce a sustainable image to be uploaded into the cloud based system to obtain the diagnostic results.



ENTOPSIS

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Direct Ophthalmoscopy Simulation System

Team #10: Alejandro Rodriguez, Eric Schafer, Jorge Calderon, Leon Dawson
Faculty Advisor: Dr. Shuliang Jiao
Company Sponsor: F.I.U. S.T.A.R. Center

Alejandro Rodriguez

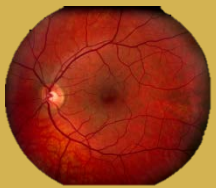
Eric Schafer

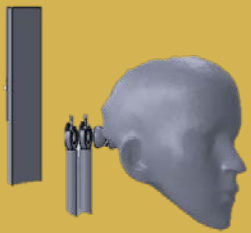
Jorge Calderon

Leon Dawson

Abstract

The project is to improve student-teacher communication during direct ophthalmoscopy simulations. Direct ophthalmoscopy is performed daily in medical practice, which is a non-invasive procedure for detection of a variety of eye diseases. However, current training capabilities for this procedure are limited and cannot meet the requirements for a medical student, which demands a more fundamental, yet systematic and guided training protocol. Current training products use mannequin heads with physical slides to display images of the fundus (retina). Our system improves upon the visual aspects of this methodology by utilizing digital media on a tablet with a large library of images of internal eye pathology. Additionally, the system will allow the instructor to edit the images and customize them to the training session at hand. The system can react to light intensity levels and dictate pupil radius between 2 mm – 7 mm.





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Florida International University

FIU Biomedical Engineering
Florida International University

Optimizing Tubing and Housing of Peristaltic Pump System for Drug Reconstitution

Team 11: Gabrielle Estevez-Inoa, LaTerika Kelly, Isis Machado, Celine Wassaf
Faculty Advisor: Dr. Anuradha Godavarty
Company Sponsor: SHL Pharma

Gabrielle Estevez-Inoa

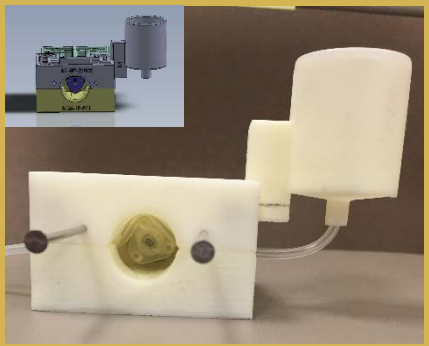
LaTerika Kelly

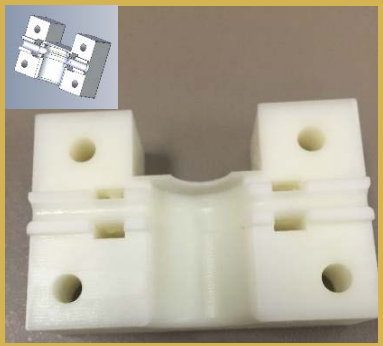
Isis Machado

Celine Wassaf

Abstract

The purpose of this project is to optimize the removable components of a desktop peristaltic pump system developed by SHL-Pharma. The peristaltic pump system aims to automate the reconstitution of injectable drugs stored in vials, a process that is currently done manually but presents variability in mixing. Unfortunately, the current system creates a problem whereby the tube becomes permanently occluded resulting in unsteady flow rate. The objective of this project is to optimize the tube and tube housing of the peristaltic pump system such that it provides a steady flow rate for fluids of various viscosities ranging from 1 cP – 10 cP. In order to achieve this goal, a device was designed to test the optimal tubing characteristics and optimal housing dimensions, which affects the bend radius of the tube. After performing statistical analysis on the data collected from flow rate and pressure testing, the optimal design specifications are chosen. These specifications will be incorporated into SHL-Pharma's peristaltic pump system, which will be a revolutionary method for drug reconstitution for self-injection.





SHL PHARMA

FIU Biomedical Engineering
FLORIDA INTERNATIONAL UNIVERSITY

Bio Impedance Sensor

Team 12: Jorge Amieba, Zachary Llaneras, Noel Lopez, Catalina Velasco
Faculty Advisor: Dr. Chenzhong Li
Company Sponsor: Gamechangertec


Jorge Amieba

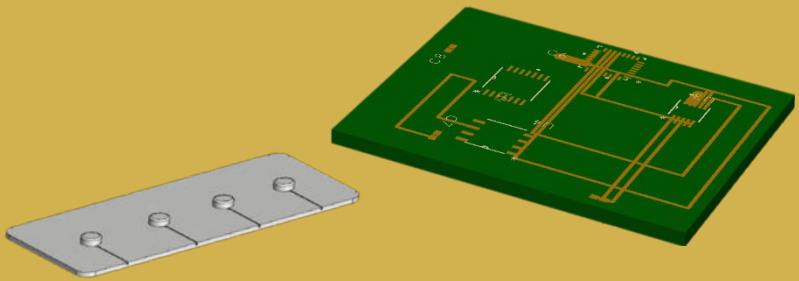

Zachary Llaneras


Noel Lopez


Catalina Velasco

Abstract

Dehydration is a common failure factor in an athlete's performance. As athletes exercise and their bodies dehydrate, fluid contents in the intracellular and extracellular compartments become unbalanced. Such osmotic fluctuations cause the impedance of the skin to vary during exercise. The purpose of this project is to design and construct a sensor that reads skin impedance levels in athletes so that, eventually, impedance levels can be directly linked to the precise hydration of an athlete. Therefore, it will allow athletes and trainers to monitor hydration conditions in real time, without having to perform any clinical tests. Our prototype is focused on determining the impedance of the skin by applying an alternating current at different frequencies. Current modalities limitations include inconvenience, delayed results, and invasiveness. Therefore, the long-term goal is to correlate the impedance levels with hydration levels.



GAMECHANGERTEC

FIU Biomedical Engineering
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Lumbar Puncture Simulator

Team 13: Jonathan Giraldo, Sally Gorenstein, Kathleen Quijada, Claudia Valle
Faculty Advisor: Dr. Nikolas Tsoukias
Company Sponsor: STAR Center at FIU


Jonathan Giraldo


Sally Gorenstein


Kathleen Quijada


Claudia Valle

Abstract

On average, in the United States, three out of five women receive an epidural or spinal anesthesia during labor. If the procedure is not performed correctly, these women could be at risk for bleeding, infection, nerve injury, nerve palsy, and severe migraines. Our project consists of a high fidelity lumbar simulator of regions L2-L5. It contains a circuit system to generate visual feedback when the injection traverses the epidural space and the spinal cord. This simulator will allow aspiring medical professionals to train and obtain the necessary skills to perform epidurals and spinal taps before injecting patients. It will minimize human error by providing students with life-like tissue for a more realistic training. An imperative aspect of lumbar injections is differentiating between the epidural space and the spinal cord and knowing how far the needle has entered the spinal cord. Injecting too far into the spinal cord will paralyze the patient. Therefore, providing visual feedback between the epidural space and spinal cord is an improvement from current modalities.

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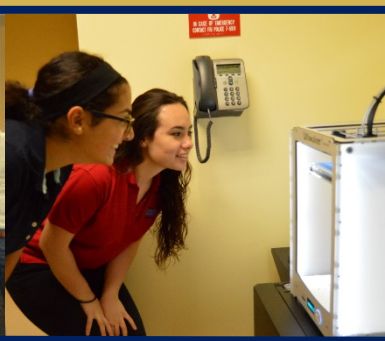

The Department of Biomedical Engineering thanks the engineers and managers of the sponsoring companies as well as our clinical sponsors for offering the Senior Design projects and for their continued student guidance and support.

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