College of Engineering

R&D Expo

Senior Design

University of North Texas

Spring 2025

COLLEGE OF ENGINEERING
Department of
Biomedical Engineering

Senior Design Abstracts
Spring 2025

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AIMMS

Smart Posture Correction Shirt with Haptic Feedback

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External Sponsors/Mentors

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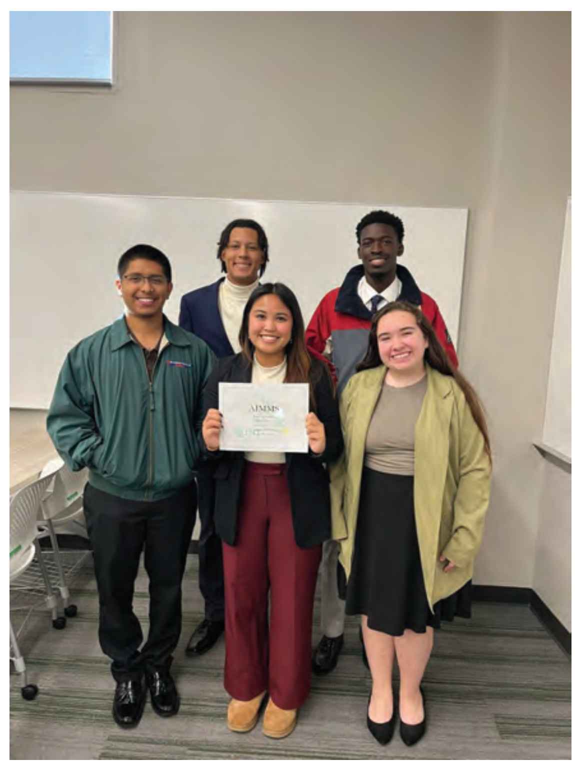
Dr. Moo-yeal Lee

Abstract

Poor posture is a bad habit that can cause the development of serious health issues including back pain, decreased lung capacity, and spinal deformity. Back braces are a current solution to poor posture but are a temporary fix that only mechanically props up the user while it is worn. Current solutions are also costly, which hinders patient accessibility. To address this gap in effective, accessible solutions, AIMMS is designing a Smart Posture Correction shirt that teaches good posture by providing haptic feedback in the form of a vibration when the user is out of their good posture state. The haptic feedback helps teach good posture by serving as a reminder to develop this healthy habit. The Smart Posture Correction Shirt is designed with a conductive thread which acts as a variable resistance sensor that changes electrical resistance when physically stretched. This device is intended to be a long-term solution to posture correction by instilling this habit into shirt users and preventing consequent health issues.



We'd like to acknowledge and thank Dr. Manish Vaidya, Dr. Xiaodan Shi, Nicole Berry, Camrie Johnson, and Dr. Moo-yeal Lee for their time, guidance, and support throughout this project.

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Axon SOLUTIONS

ENID
Electrical Neuropathy-Inhibiting Device

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Abstract

Chemotherapy-Induced Peripheral Neuropathy (CIPN) is a painful complication of chemotherapy, affecting up to 85% of patients; often leading to dose reductions or treatment discontinuation. Current interventions consist of cryotherapy or compression therapy, which exhibit limited efficacy. ENID facilitates the delivery of a non-invasive, neuromodulation approach to CIPN treatment and prevention by creating an interface to deliver controlled electrical stimulation to the median nerve, leading to the inducement of vasoconstriction in the brachial artery to reduce chemotherapeutic agent exposure to the peripheral nerves in the extremities.

This wrist-worn device is designed to adhere to electrical medical device safety standards such as IEC 60601-1 and IEC 60601-2-10 while having the ability to fit a range of patient wrist sizes. Its efficacy is assessed through COMSOL Multiphysics simulations modeling human vascularization for vasoconstriction and electrode-tissue interactions. ENID seeks to assist in mitigating CIPN and provide a clinically viable solution for prevention by offering a more effective, affordable, and comfortable patient-centered alternative to existing therapies.

We would like to acknowledge The Realtime Group and Cooper Wood for their sponsorship and support for this project. We'd also like to express gratitude to Dr. Xiaodan Shi, Nicole Berry, and the BMEN department for their continuous guidance.

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Brain Spark: Eduacational Electroencephalogram and Application

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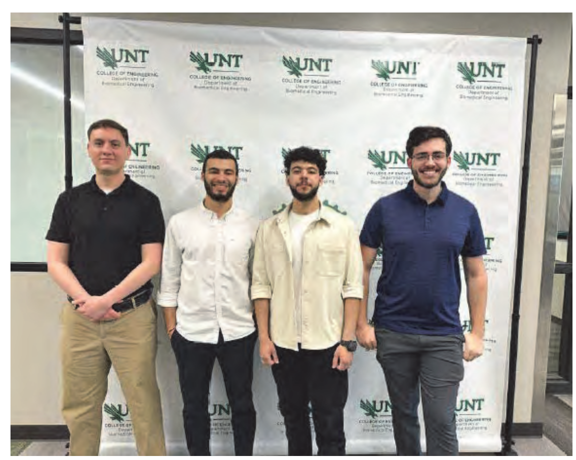
Abstract

An electroencephalogram (EEG) is a non-invasive exploratory device that is used to view brain activity in a patient. These devices provide specialists with a method to detect abnormal electrical signals being transmitted between neurons and interpret those results for further diagnosis. These signals require processing before they can be understood, and this presents an opportunity for aspiring Biomedical Engineers to receive practical, hands-on experience with a complex subject.

Our goal is to provide an affordable EEG that can be manufactured in almost any Biomedical Engineering department, utilizing common components, software, and manufacturing techniques. To achieve this, we leverage a robust design for 3D printing, easily sourced components, and a practical software package using MATLAB that provides a comparable readout to that of commercially available units. This project aims to provide an effective platform to enable a more productive educational experience for future Biomedical Engineers at a significantly cheaper price per headset.



Special Thanks to: Nicole Berry and Camrie Johnson

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SureStep 4.0

Cygnus Steps

Team Members

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Abstract

Falls are a major health concern among the elderly population, often leading to injuries that require extensive rehabilitative care to restore mobility. Traditional rehabilitation methods can be costly and demand prolonged physical therapy sessions. SureStep 4.0 addresses these challenges by providing a data-driven approach to rehabilitation, enabling physical therapist to develop more personalized treatment plans. By measuring electromyography (EMG) signals from the lower limb muscles, the device delivers critical insights into muscle activation patterns, allowing physical therapists to assess patient progress and determine best point of action going forward. Additionally, SureStep 4.0 features a haptic and audio alert system that notifies users when they are in an unbalanced position. With continued use in rehabilitation settings, the device is expected to improve muscle coordination, balance, and overall stability. By bridging the gap in current fall rehabilitation methods, SureStep 4.0 allows both patients and healthcare providers with a deeper understanding of patient conditions, ultimately promoting a safer and more effective recovery.

Cygnus Steps would like to give special thanks to Mr. Pettinger, Dr. Shi, Dr. Vijay, Dr. Chan, Nicole Berry, & Camrie Johnson as well as their family and friends

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DYNAMIC CELLUTIONS

Dynamic stretcher fabrication for mechanically modulating cardiac cells in 3D

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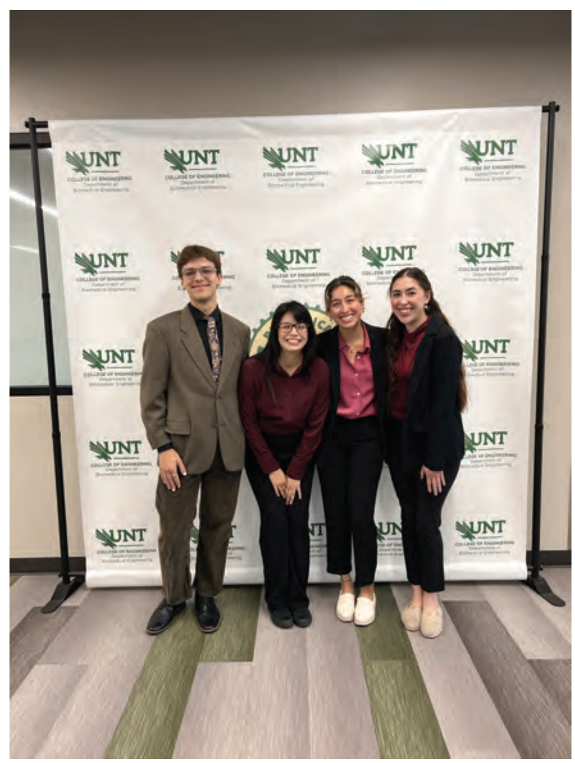
Abstract

Familial hypertrophic cardiomyopathy is one of the most common genetic disorders occurring in 1 in 500 people, characterized by the thickening of the left ventricle, with many individuals being asymptomatic or displaying mild symptoms emerging in adolescence or early adulthood. The current gap in the understanding of the disease mechanisms hinders the development of targeted pharmaceuticals for its treatment. In this work, we present a novel dynamic cellular stretcher designed to apply cyclic uniaxial stress and strain to cells cultured in a biomimetic environment. The system offers precise control over the magnitude, frequency and duration of cyclic strain through the BLYNK IoT interface. Using human induced pluripotent stem cells differentiated into cardiomyocytes, we demonstrate its potential to recapitulate the mechanosensitive pathways involved in HCM, while also promoting maturation into adult-like cardiomyocytes. This enables for real-time monitoring of contractility and calcium handling under dynamic conditions providing a versatile platform for investigating the interplay between mechanical forces and cellular behavior in cardiovascular research and beyond. Our findings aim to guide the design of tissue engineering scaffolds and microfluidic systems, advancing the understanding of how mechanical stimuli can influence cell behavior in engineered environments.



Dynamic Cellutions would like to acknowledge and express our sincere gratitude to Dr. Huaxiao Yang, Joel Abogaye, Dr. Xiaodan Shi, Nicole Berry, and the UNT Biomedical Engineering Department for their invaluable guidance, support, and resources.

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ELEVATE MEDICAL: Tissue Denuding System

ELEVATE MEDICAL

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Abstract

Bone grafting is a critical procedure, with approximately 500,000 surgeries performed annually in the United States. The current gold standard for bone grafts are autografts, these involve harvesting a patient's own bone (typically from the iliac crest) and cleaning it of soft tissue and cartilage. Then, this bone is milled into fine particles so it can be used for grafting. All of these steps are completed within a single surgical procedure. Because of this, surgeons can face several challenges. Some of these challenges include the manual cleaning process taking an average of 27-40 minutes to complete, the fatigue a surgeon experiences during this labor intensive process, potential injury of the surgeon, and increased operating room time. Additionally, prolonged anesthesia poses risks to patient health. Furthermore, incomplete removal of soft tissue and cartilage can compromise graft integrity, creating voids that weaken structural support.

To address these issues, the Tissue Denuding System created by Elevate Medical aims to utilize pressurized saline to efficiently clean bone for graft preparation. This device aims to reduce cleaning time to 5-10 minutes. This will minimize surgeon fatigue, decrease operating time, and ensure a higher quality bone graft. The technical proposal will outline the device's design, economic feasibility, regulatory considerations, and testing protocols. Therefore it will offer a comprehensive solution to improve the autografting process for both surgeons and patients.

We would like to thank Dr. Shi, Dr. Won, Nicole Berry, Medtronic Engineers Sophie Pervere and Amelia Robinson and the UNT Biomedical Engineering Department for all their guidance, resources, and support.

Automatic Motorized Swivel for in-vivo Neural Recording in Pre-clinical Research

Team Members

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- Anjita Budhathoki

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Dr. Lin Li

Abstract

Cable twisting and tangling during in vivo neural recordings pose significant challenges, especially in live rodent models. Current solutions, such as commutators, require complex assembly and can lead to inefficient setups and flawed data. We present a motorized swivel system with an integrated anti-twisting mechanism that simplifies neural recording procedures. This compact system combines a rotor, stator, magnetic sensor, commutator, rotor PCB, and motor control, all assembled using affordable 3D-printed parts. With a production cost under $500, the device is cost-effective, customizable, and adaptable to various laboratory setups. Most importantly, the motorized rotor minimizes torque on the animal's head, improving comfort and reducing behavioral disruption within recorded data. This innovation enhances data reliability and supports ethical research practices by minimizing animal distress. Our motorized swivel system offers a streamlined, cost-efficient solution, advancing preclinical neural recording methodologies.

We would like to express our heartfelt gratitude to Dr. Lin Li, Dr. Xiaodan Shi, Nicole Berry, and Camrie Johnson for their invaluable support and guidance throughout this project. Your assistance has been greatly appreciated.

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ROBIO TECH

VINE-BOT 3000: A growing & steerable, miniature soft-body robot for future applications in endoscopic procedures

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Abstract

Endoscopes are essential diagnostic and surgical tools enabling clinicians to examine internal body structures. However, conventional endoscopes suffer from limitations, including rigid tips capable of causing internal perforations and restricted maneuverability, which reduces the effectiveness and safety of these procedures. To address these challenges, ROBIO Tech introduces the Vine-Bot 3000, an innovative magnetically-actuated soft robotic endoscope.

The Vine-Bot 3000 possesses an AI-enhanced miniature camera and utilizes a manually controlled magnetic tip alongside its eversion, allowing it to achieve enhanced motion with robotic actuation being considered for future designs. Its soft body design also ensures smooth motion and reduced chance of puncturing internal tissue.

Ultimately, the Vine-Bot 3000 promises safer, more effective, and cost-efficient endoscopic procedures, significantly improving patient outcomes and clinician experiences.

We thank Dr. Amir Jafari, Rashmi Wijesundara, Dr. Xiaodan Shi, Nicole Berry & Camrie Johnson for their support and guidance during the length of

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STEP WORKS Biomedical

The SPOT Walker: Spot Assisted Mobility Walker

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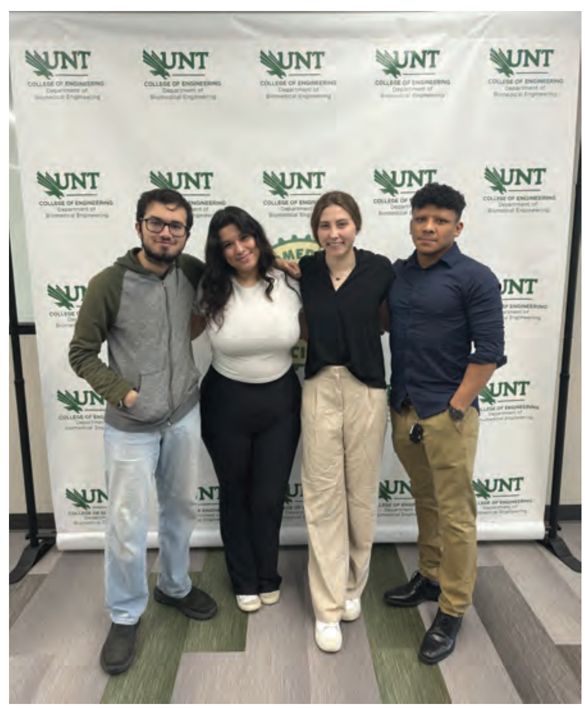
Omar Cavazos

Abstract

The state standard for senior caregiving facilities is at minimum 1 caretaker for every 20 patients; 75% of these patients require assistance for at least 3 daily mobility activities. This extreme ratio leads to overworked staff and lower quality of care for patients, and elderly population growth projections show this problem will continue. We have designed a connection system that interfaces the Boston Dynamics SPOT robot with commonly used rollator walkers. Its features include an apparatus to form a rigid connection to transfer forces between SPOT and the user for mobility assistance and fall prevention through SPOT's balancing feature. Simple keyboard controls command SPOT's direction and assist in the one-step coupler lock. Safety features are included such as a heart rate sensor to monitor overexertion, and an emergency release. The series of integrated features listed creates a system that assists caregivers in augmenting the independence of mobility impaired patients without compromising their safety, thus increasing caretaker efficiency while improving patients quality of life.



We would like to thank Omar Cavazos and Dr. Vijay for their support and guidance along with the ARM lab for providing SPOT.

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TREMEDYNE
TREMOR SOLUTIONS

The Tremedyne Tremor Suppressive Glove

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N/A

Internal Sponsors/Mentors

Faculty Advisor : Dr. Amir Jafari
Project Sponsor: Daniel Johnson

Abstract

Essential tremor (ET) is a progressive neurological disorder characterized by involuntary oscillatory movements, typically affecting the hands. These tremors can significantly impair a patient's quality of life. The Tremedyne Tremor Suppressive Glove is a wearable device that incorporates active orthosis technology to suppress the condition of Essential Tremor in the hands. The glove utilizes continuous rotation servos, position detecting sensors, and accelerometers coupled with an Arduino Mega to detect the desired hand position and spool the servos actively. The glove contains a mechanical pulley system with internal wire and silicone tubing that runs along the fingers and connects to spool attachments on servo motors to pull the fingers into the desired position. The glove also features a dual-mode functionality, allowing users to switch between free-motion and locking states with button commands. This device allows ET patients to perform essential daily tasks such as eating without caretaker assistance.

We would like to thank our sponsor Daniel Johnson for his support and guidance.

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VINEWORKS

Handheld Tracheal Intubation Device

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Abstract

Tracheal Intubation is a critical procedure in emergency settings requiring both precision and accuracy to minimize potential trauma to sensitive tissue, while allowing for airflow to the lungs. Current devices are often rigid in nature, which leads to these devices having limited adaptability to varying anatomical structures in the mouth and throat making trauma occurrence likely. Additionally, this procedure requires highly trained professionals, tracheal intubation is difficult to learn under high stress environments where lack of oxygen for a patient could be detrimental.

To address these challenges, we propose a Handheld Tracheal Intubation Device using soft robotics technology. The device features a portable, lightweight design that requires minimal training to operate. With the design of the soft everting robot the possible human error can be minimized, along with the likely damage to the surrounding tissues. The goal of the device is to effectively open constricted airways during emergencies and to reduce the occurrence of potential trauma from performing lifesaving tracheal intubations. Our device has the potential to revolutionize emergency airway management by providing a more adaptable, user-friendly, and safer solution.

VineWorks would like to thank our mentor Rashmi for all of the support and guidance she has shown us through the year. We would also like to thank the Biomedical Engineering Department for everything they have done for us over the years.

ZemaLink: Skin Hydration Alerting Device

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External Sponsors/Mentors

The RealTime Group, LLC

Internal Sponsors/Mentors

Dr. Melanie Ecker

Abstract

Eczema is a chronic skin condition that weakens the skin barrier, leading to irritation, inflammation, and increased sensitivity due to reduced hydration. There is no cure, treatment adherence remains a challenge for many patients. To address this, ZemaLink, with the sponsorship of The RealTime Group, has developed an innovative two-part system consisting of a wearable device and a web application. ZemaLink monitors the skin's hydration levels using embedded sensors and alerts the user when their skin becomes too dry, reminding them to follow their prescribed treatment plan. These alerts are sent through the web application, where users can also track their hydration trends over time. By providing real-time feedback and long-term insights, ZemaLink empowers individuals to take a proactive approach in managing their eczema and preventing flare-ups.

We would like to express our sincere gratitude to The RealTime Group, LLC, Cooper Wood, Dr. Ecker, and the UNT Biomedical Engineering Department for their guidance and resources.

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