Ronald E. McNair
Postbaccalaureate Achievement Program
Summer Research Symposium
July 29-30, 2021

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Ronald E. McNair
Postbaccalaureate Achievement Program

July 29, 2021

Welcome to New Jersey Institute of Technology's 2021 URI Undergraduate Summer Research and Innovation Symposium. The impact of COVID19 pandemic has somewhat subsided. It is, therefore, an honor and privilege to be part of this year's in-person Undergraduate Summer Research and Innovation Symposium. The participants of Ronald E. McNair Postbaccalaureate Achievement Program have started as a virtual program in May 2021, but we were able to meet a few times and the students were able to attend the labs for their research. Because of the pandemic India's Heritage Institute of Technology was remain canceled. The Ronald E. McNair Program students worked very hard in a hybrid mode to carry out their research projects with literature review, data analysis and simulation in addition to lab experiments. This year's success comes because of Ms. Zara Williams, Assistant Director and Prof. Ashish Borgaonkar, the Faculty Coordinator of the Ronald E. McNair Program, for their efforts in coordinating the programs. Efforts of Mr. Marlon Rodriguez and Ms. Eisha Syeda, of the Ronald E. McNair Program are recognized for their valuable input in producing this program's booklet and certificates.

The students in the Ronald E. McNair Program have the opportunity for in-person presentation of their research accomplishments that was completed under the supervision of dedicated NJIT faculty. Without the time and effort of NJIT faculty and graduate student mentors the outstanding achievement of the students would not have been possible. Many students were able to meet their advisors in the labs to move their research forward.

In this second year, we missed Prof. Angelo Perna, the long-time Director of the Ronald E. McNair Program. His contributions to this program will be cherished by all the students he touched and the entire NJIT community.

We are extremely proud of the research efforts of all the students, the quality of the research presentations and grateful for the support of the NJIT administration, faculty, and staff in contributing to the success of today's event.

Sincerely,

Durgamahab Misra, PhD
Symposium Co-Chair and McNair Program Director
Professor and Chair
Department of Electrical and Computer Engineering

Ronald E. McNair Postbaccalaureate Achievement Program 2021 Scholars

Alan Lundi - Civil Engineering
Research: *Remediation of PFAS Contaminated Environmental Soil and Sediment*
Faculty Adviser: Dr. Jay Meegoda, Department of Civil & Environmental Engineering

Andressa Marangon - Electrical & Computer Engineering Technologies
Research: *Engineering the Carrier Dynamics of III-Nitride Ultraviolet Nanowire Light-Emitting Diodes*
Faculty Adviser: Dr. Hieu Nguyen, Department of Electrical & Computer Engineering

Jason Ogbebor - Chemical Engineering
Research: *Compressibility of Water Confined in Carbon Nanopores Via Molecular Dynamics Simulations*
Faculty Advisor: Dr. Gennady Gor, Department of Chemical & Materials Engineering

Jonathan Grabiel-Padon - Mechanical Engineering
Research: *Modelling Complex Mechanism Simulations on Creo: Toothbrush Attachment*
Faculty Adviser: Prof. Balraj Mani, Department of Mechanical & Industrial Engineering

Lara Rios - Civil Engineering
Research: *Open-Source, Low-Cost Lead Sensor Module*
Faculty Adviser: Dr. William Pennock, Department of Civil & Environmental Engineering

Michael De La Cruz - Mechanical Engineering
Research: *Concept design of a lightweight, modular, and adjustable lower-extremity exoskeleton*
Faculty Adviser: Dr. Xianlian Zhou, Department of Biomedical Engineering

Paul Ogunleye - Electrical & Computer Engineering Technologies
Research: *Drones Swarms for Payload Transportation*
Faculty Adviser: Dr. Pramod Abichandani, School of Applied Engineering & Technology

Salma Alami Yadri - Electrical Engineering
Research: *Building a self-sufficient community microgrid: an investigation on its strategies and technological implementation.*
Faculty Adviser: Dr. Philip Pong, Department of Electrical & Computer Engineering

Samantha Augustin - Computer Science
Research: *Examining the Impact of Engineering Entrepreneurship Courses on Students*
Faculty Adviser: Dr. Prateek Shekhar, School of Applied Engineering & Technology

Simone Bishara - Biochemistry
Research: *Observing Compressive Strength of Fibrin Hydrogels of Varying Concentrations*
Faculty Adviser: Dr. Jonathan Grasman, Department of Biomedical Engineering

Thomas Martinez - Mechanical Engineering
Research: *Design of Adjustable Instrumented Crutch for Compressive Force Analysis*
Faculty Adviser: Dr. Saikat Pal, Department of Biomedical Engineering

Remediation of PFAS Contaminated Environmental Soil and Sediment

Scholar: Alan Marthel Lundi, Advisor: Dr. Jay Meegoda
Civil and Environmental Engineering
New Jersey Institute of Technology, Newark NJ 07102

Per- and polyfluoroalkyl substances (PFAS) are a complex class of pollutants found in all six continents of the world. Solids such as soils and sediments are contaminated with PFAS from the use of aqueous film-forming foams (AFFF) at defense sites, airports, and fire training sites. Such solids can act as secondary sources of PFAS contaminated water, leading to bioaccumulation in micro-invertebrates, other organisms in the terrestrial and aquatic food web, and ultimately humans. Many existing water treatment technologies (e.g., incineration) as well as emerging technologies (e.g., activated carbon, anion exchange, chemical and electrochemical oxidation) have shown limited success in mineralizing recalcitrant and persistent PFAS. Ultrasound can degrade PFAS by the cavitation and implosion of nano bubbles formed during cavitation causing high-temperature pyrolysis and interaction with free radicals formed during nano bubble implosion. Fig. 1 Explains the process of bubble formation during ultrasound in water contaminated with PFAS. This project investigates the application of ultrasound as a cost-effective and reliable treatment to remove and mineralize PFAS adsorbed by solids. The overall objectives of this project are: Quantify the effectiveness of ultrasound technology in desorption and mineralization of PFAS in soil and sediments; Optimize critical technical parameters such as frequency, power density, residence time, and reactor geometry; and 3) A destructive field treatment technology for PFAS contaminated soils. Initial results shows that PFAS concentration in water (contaminated by PFAS) decreases by increasing the time of ultrasound treatment. We plan to extend this work to PFAS adsorbed by soil to remove PFAS.

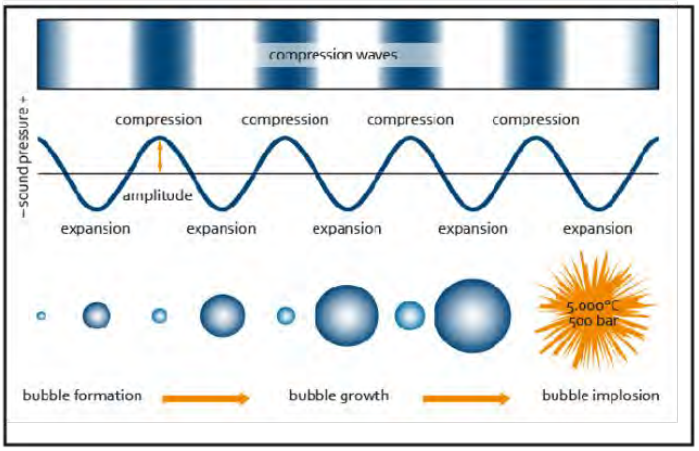

Figure 1. Scheme of bubble growth and collapse

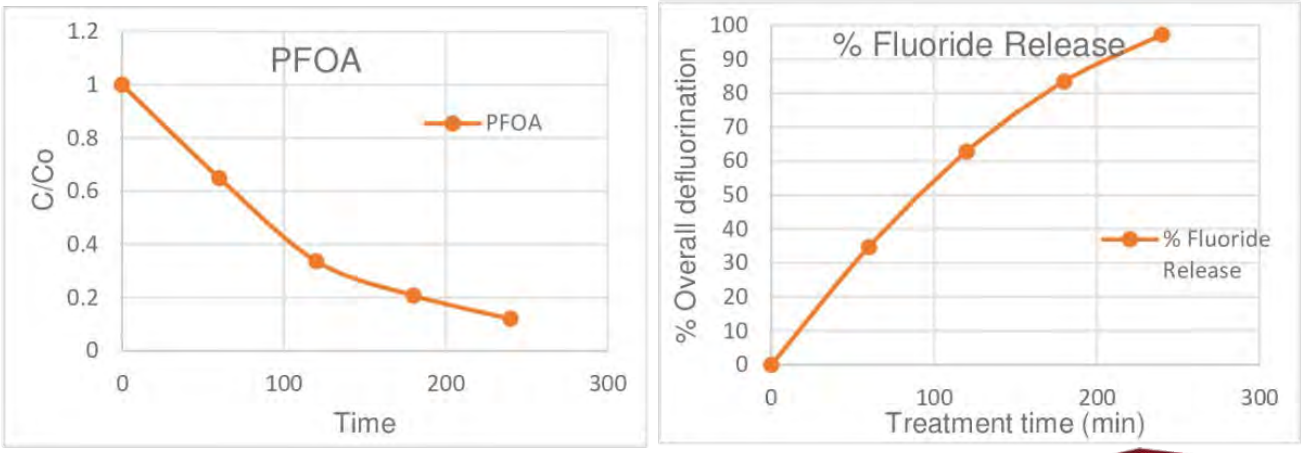

Figure 2 Sonochemical degradation of PFOA with time to total Energy.

Engineering the Carrier Dynamics of III-Nitride Ultraviolet Nanowire Light-Emitting Diodes

Scholar: Andressa Marangon, Advisor: Hieu Pham Trung Nguyen, Ph.D.
Barsha Jain – PhD Candidate, Victor Bui - Phd Graduate
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: We report on the demonstration of a new type of axial nanowire LED heterostructures, with the use of self-organized Aluminum Gallium Nitride (AlGaN) dot-in-a-wire core-shell nanowire arrays. The large bandgap in AlGaN shell is spontaneously formed on the sidewall of the nanowire during the growth of AlGaN barrier of the quantum dot active region. As such, nonradiative surface recombination, that dominates the carrier dynamics of conventional axial nanowire light emitting diodes (LED) structures, can be largely eliminated, leading to significantly increased carrier lifetime 6.5 ns. The luminescence emission is also enhanced by orders of magnitude. Moreover, the p-doped AlGaN barrier layers can function as distributed electron blocking layers (EBLs), which is found to be more effective in reducing electron overflow, compared to the conventional AlGaN EBL.

Compressibility of Water Confined in Carbon Nanopores Via Molecular Dynamics Simulations

Scholar: Jason Ogbebor, Advisor: Dr. Gennady Gor
Department of Chemical and Materials Engineering
New Jersey Institute of Technology, Newark NJ 07102

The thermodynamic properties of fluids confined in nanopores have been shown to differ from those of the bulk (non-confined) fluid. Thermal expansion, freezing point, density, and transport coefficients are all examples of properties affected by nanoconfinement. Of particular interest is the effect of nanoconfinement on a fluid's elastic properties. These elastic properties determine the speed at which elastic waves propagate through the material. When a porous material is saturated with a fluid, its elasticity is measurably changed. This makes ultrasonic wave propagation an important technique in geophysical characterization to extract information about the presence of fluids in geological porous media. Within the last five years, Dr. Gor's group has been examining the thermodynamic properties of nanoconfined fluids, and in particular compressibility, with a main focus on cryogenic liquids (nitrogen, argon, methane). In this research, the methods used in Dr. Gor's group are applied to a study of the compressibility of confined water. This research aims to study the effects of the pore size and the external pressure on the compressibility of water through molecular dynamics simulations. Since water is ubiquitous in nature, these results will have implications for better understanding wave propagation in water-saturated nanoporous media.

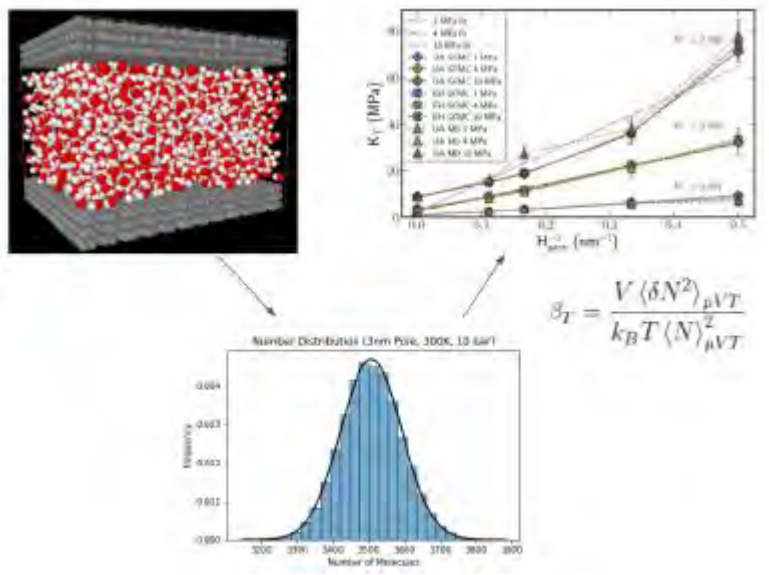

Figure: Research methodology; determining fluid compressibility from the distribution in the number of water molecules in a carbon nanopore.

Modelling Complex Mechanism Simulations on Creo: Toothbrush Attachment

Scholar: Jonathan Grabiel-Pabon, Advisor: Balraj Mani
Department of Mechanical and Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Creo Parametric is a set of solid modelling programs used for computer aided design supporting product design. The program offers many features for 3D modelling, performing analysis, running simulations and more. The study focuses on modelling complex mechanisms on Creo Parametric to be able to fabricate animations for Designwell.me. Designwell is a search-enabled website that serves as a large database where animations of mechanisms are archived and displayed. This website serves as the first step for mechanical engineers in product design as well as the idea-seeking entrepreneurs to help innovation and design well. The main goal of my research was to be able to model and simulate 30 different mechanisms. During my research I was able to complete 3 mechanisms, a Slicing mechanism, a Four-Bar Geneva, and a Locking-Slide Geneva mechanism. After the completion of these three mechanisms, I moved onto a bigger project which involved various techniques learned throughout the research. This is the toothbrush attachment mechanism. For this project, I was able to learn the fundamental components used to make an electric toothbrush. This required dismantling/breaking the toothbrush to be able to design the internal components. Measurements were made with vernier calipers to accurately model all the parts. After the making of the electric toothbrush and its internal components an assembly on Creo Parametric was made. Then I pursued a novel flossing attachment that was adapted to the design of the toothbrush. This was our initial goal and idea from the beginning of the research. The goal is to be able to switch simultaneously between a brushing attachment and flossing attachment with ease. Both attachments serve the same goal which is to be able to provide a much deeper and efficient cleaning of the teeth for dental hygiene. This idea first came to mind to Professor Mani. I was tasked to be able to adapt and hopefully have a prototype ready by the end of the summer. The flossing attachment works with the same motion needed to rock the brushing attachment by allowing the flosser to reciprocate left to right. This reciprocating motion allows for flossing to be done at ease and quickly rather than tradition time consuming way. Such a tangible attachment will be an attraction to children promoting the practice of dental flossing at an early age.

Open-Source, Low-Cost Lead Sensor Module

Scholar: Lara Rios, Advisor: Dr. William Pennock
John A. Reif, Jr. Department of Civil and Environmental Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Water supplied by lead service lines poses a significant threat to people because of its potential to elevate blood lead levels and cause serious harm to a child's central and peripheral nervous systems. The risk is most commonly monitored through the testing of samples that are individually collected and sent to a lab for a costly analysis. This work aims to improve water system operation by creating an open-source, low-cost, long-lasting lead sensor module with the ability to wirelessly transmit lead concentrations. Components were gathered that are low-cost but still capable of getting the job done including: KeeYees Development ESP32 Microcontroller, Thomas Brand Lead Ion Selective Electrode, and Comidox Voltage Boost Converter Board. To prepare for the testing of the lead sensor, a computer software program was used to get an estimate of what lead levels we should expect to see during future trials. The Visual MINTEQ program required some additional inputs to run the simulation, so reduction potential constant and stability constants were found to fill in those gaps. The concentrations from the software will be compared to the sensor module's results when connected to a pipe loop that has recently been updated and repaired. All information relevant to the development of the sensor module will be available on the website we made, which is responsive (accessible on computers and mobile devices). This site currently allows individual profiles to be created so, in the future, different locations can monitor their modules and review a graph that summarizes their data over time.

Concept design of a lightweight, modular, and adjustable lower-extremity exoskeleton

Scholar: Michael De La Cruz, Advisor: Dr. Xianlian Zhou
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark, NJ 07102 USA

Abstract: Robotic exoskeletons have demonstrated their ability to improve human performance in many ways. These devices can reduce the metabolic cost of daily activities such as walking and running by providing well timed assistance to the human joints. Therefore, they have found their application in areas such as rehabilitation, industrial settings, and the military. Some common challenges that come with designing an exoskeleton are the quality of fit, cost, efficiency, ease of use, and ultimately the question whether it offers a reduction in metabolic cost and injury risks. The exoskeleton designed in this work aims to be lightweight, modular, and adjustable. It uses collars along the links that resemble shaft collars and provides freedom for adjustment to fit wearers of different heights and sizes. We attached servo-actuated motors along the hip and knee joint using aluminum links. The motors will connect to a controller unit attached to the hip brace and assist with the flexion/extension of the hip and the knee. The motors can be turned on and off as required, making the switching from passive mode to assisted mode easy. We believe that with optimized torque profiles; the designed exoskeleton will be able to reduce the metabolic cost of walking and running activities and increase the endurance in the user. The design notes and results developed in this study will pave the way for improving the design of the lower-extremity exoskeletons.

Drones Swarms for Payload Transportation

Scholar: Paul Ogunleye, Advisor: Dr. Pramod Abichandani, Mentor: Deepan Lobo
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According to the United States Fire Administration, the total deaths per year from fires has increased every year since 2012. The most important thing during an emergency response is time. If the time it takes to locate points of interest is reduced, then the amount of lives saved can be increased. Drones can be used during rescue operations by searching a larger area faster along with different types of visual aids. The purpose of this research is to make multiple drones swarm together in order to control their actions from a ground station computer. From the computer flight path, payload deployment, and any equipment connected to the drones can be controlled. The pixhawk 2.1 is the autopilot used to control the drone along with a raspberry pi which is used to send and receive commands from the ground station computer. Python scripts are used to control the drone's flight path and can be changed at the discretion of the user. Using the flight controller, Mission Planner, it is possible to connect multiple drones in a swarm to control them. We tested several different python scripts ranging from a simple triangle pattern to a scanning "Lawnmower" pattern. We plan to conduct further research of multiple drone swarms flying together linked to different ground station computers.

Building a self-sufficient community microgrid: an investigation on its strategies and technological implementation.

Scholar: Salma Alami Yadri, Advisor: Philip Pong. PhD
Electrical Engineering Department
New Jersey Institute of Technology, Newark NJ 07102

Abstract: In recent years, the U.S. and countries across the globe have seen a major rise in the development of microgrids. Microgrids represent a great opportunity for integrating renewable energies and thus, vital tools in the fight against climate change. The increased occurrence of natural disasters has made delivering constant and reliable power to critical facilities a major problem especially in remote areas, which is where microgrids excel. This study analyses cost-benefit analysis of building a self-sufficient community microgrid infrastructure that uses 100% Distributed Renewable Energy (DER) resources and incorporates energy storage solutions to serve over 1000 households. The study employs NREL's System Advisor Model (SAM) to model performance and financial metrics by using a time-based modeling approach based on installation and operating costs of the project and system design parameters. The study uses insights from the model to guide planning strategies which could be used to sell homes at attractive prices and encourage the switch from conventional energy to clean renewable energy.

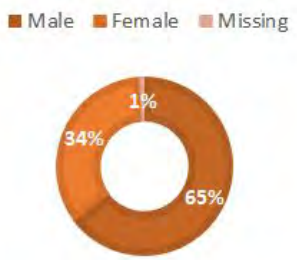
Examining the Impact of Engineering Entrepreneurship Courses on Students

Scholar: Samantha Augustin, Advisor: Dr. Prateek Shekhar
Department of Electrical and Computer Engineering
New Jersey Institute of Technology, Newark NJ 07102

Entrepreneurship is one of the driving forces that have introduced the world to countless products and services, leading to economic growth and societal impact. In recent years, with the increasing need to train engineering students in entrepreneurship, several entrepreneurship education programs (EEPs) have been created outside the business school. With this growth in EEPs, it is imperative to assess its impact on student outcomes and the effect that these courses have on the students to inform future program development. The data used in this study consists of survey responses collected from students at the beginning and end of an entrepreneurship course over three semesters. This study examines the two research questions 1) What is the impact of entrepreneurship courses on three student outcomes: entrepreneurial self-efficacy (ESE), technological self-efficacy (TSE), and risk-taking; and 2) Does technological self-efficacy predict specific factors in ESE, particularly searching, planning, marshaling, implementing finance, and implementing planning? In total, the number of pre-semester and post-semester survey responses in the study was 116. Regarding the first research question, a paired t-test was performed to examine the mean difference between the pre-semester and post-semester data and whether these differences are statistically significant. In addition, effect sizes were calculated using Cohen's d to examine how large the differences were. We found that there was a statistically significant medium to a large difference in the student's scores for all of the factors, except risk-taking. This reveals that most of the students' perceived confidence positively shifted from the beginning of the semester to the end. Regarding the second research question, to determine whether TSE can predict each ESE factor, a regression analysis was performed with TSE as the dependent variable and the ESE factors as the independent variables. The post-semester regression analysis between TSE and the ESE factors showed that TSE was a statistically significant predictor of all the factors except for searching. These results can be used in further research and inform the development of entrepreneurship programming for engineers.

Figure 1: Data Collection

Figure 2: Gender Distribution



Observing Compressive Strength of Fibrin Hydrogels of Varying Concentrations

Scholar: Simone Bishara, Advisor: Dr. Jonathan Grasman
Department of Chemistry and Environmental Science
New Jersey Institute of Technology, Newark NJ 07102

Abstract: Volumetric Muscle Loss injuries destroy the muscle's regenerative capability which results in the injured muscle's impaired functionality. Scaffolds composed of various types of polymeric biomaterials have been gaining attention as they can be used as treatment for volumetric muscle loss injuries by promoting tissue regeneration. To fabricate a properly constructed scaffold, the structural and mechanical properties must be examined in order for the scaffold to successfully fulfill its function. Hydrogels made of fibrin were made because fibrin has shown promising results as a biomaterial in tissue engineering applications due to its involvement in wound healing by forming blood clots demonstrating fibrin's biocompatible properties. The scaffold must be constructed to exhibit similar mechanical properties as the tissue site that the scaffold is being implanted in otherwise it may be rejected since it could be recognized as a foreign substance and trigger the body's immune response. The mechanical properties of the scaffold is important to consider in its design because it must be able to withstand compression from the time of implantation, during the tissue regenerative process, and after the process is complete. This study focuses on examining the compressive strength of fibrin hydrogels of varying concentrations including 5mg/mL, 10mg/mL, and 20mg/mL 2 hours and 5 hours after they were made and stored in the incubator at 37 degrees Celsius. The compressive strength of the hydrogels were tested using an Instron machine, which involves placing parallel plates to compress a sample; the compression ended when the system had reached 50% strain for all fibrin hydrogels tested; the data produced was used to calculate and graph the stress and strain values in order to determine the compression modulus which corresponds to the slope of the stress vs. strain graph. The data points that were analyzed specifically were the ones between 10%-20% strain, which is the region of our graph that is most linear; this linearity is important because it correlates to the elastic region of the hydrogel. In order to replicate physiological conditions the gels were placed in a PBS buffer when being compressed. The results showed that the average compression moduli for the 5 mg/mL gels compressed at 2 hours and 5 hours were statistically significant as well as for the 20 mg/mL hydrogels. Overall, the 20 mg/mL hydrogels had the largest average compressive strength of all the hydrogels. The statistical significance between the groups of hydrogels with varying concentrations revealed that concentration and time played important roles in the compressive strength of the fibrin hydrogels.

Design of Adjustable Instrumented Crutch for Compressive Force Analysis

Scholar: Thomas Martinez, Advisor: Dr. Saikat Pal
Department of Biomedical Engineering
New Jersey Institute of Technology, Newark NJ 07102

Crutches are a key part of rehabilitation for patients with varying conditions. The Lofstrand crutch, in this case, offers a lightweight yet sturdy option during recover. It is important to gain an understanding of the forces the crutch withstands during use by a patient as it gives an idea of how particular gait patterns interact while also allowing techniques to model patient movement during use and the forces the patient may experience as well. In order to properly analyze these forces, adjustments to the crutch model need to be made to accommodate the force measurement devices that are implemented. This research aims to modify the current Lofstrand crutch we have available in the lab and implement force sensors that would allow the compressive forces in the crutch to be measured accurately and consistently while retaining the original lightweight, adjustable, sturdy, and unobstructive features from the original. The new features were modeled using Creo Parametric 7.0 and were tested in static loading simulations to ensure structural integrity during the loading. The load measurement system would use strain gauges in order to convert the strain measurements into a digital load measurement to give a quantifiable measurement of the forces at the given locations. Based on the simulations after applying the new design, the modified design is both structurally sound and lightweight. The next step would involve manufacturing the new parts, implementing circuitry and strain gauges onto the model to allow data collection and testing the physical model to ensure the measurements collected are accurate and precise. This modified crutch opens future study opportunities to understand how the crutch and the patient react during use for many afflicting conditions.

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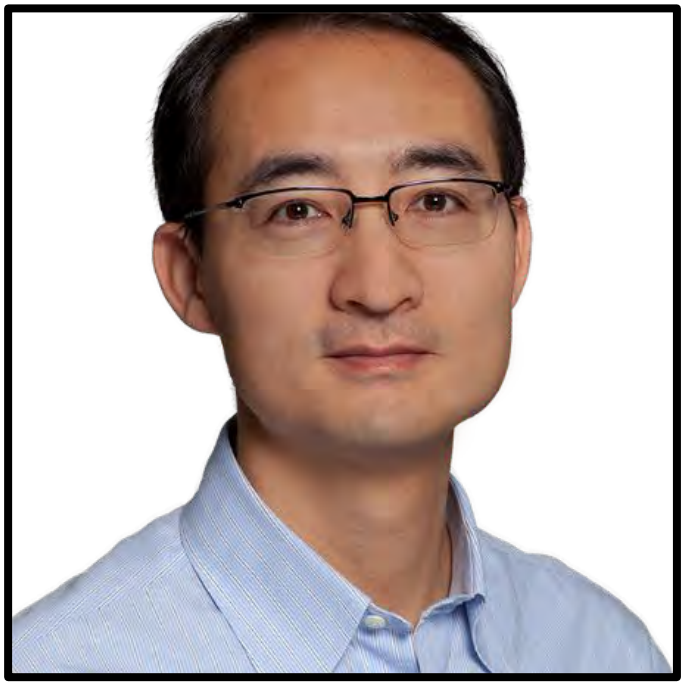

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