Graduate Projects Meeting
April 28, 2023

Project Initiation Steps

1. Understand the Course Requirements and Procedures
2. Project Proposal Requirements
3. Exploring the available Projects
4. How to add the course

Course Requirements and Procedures

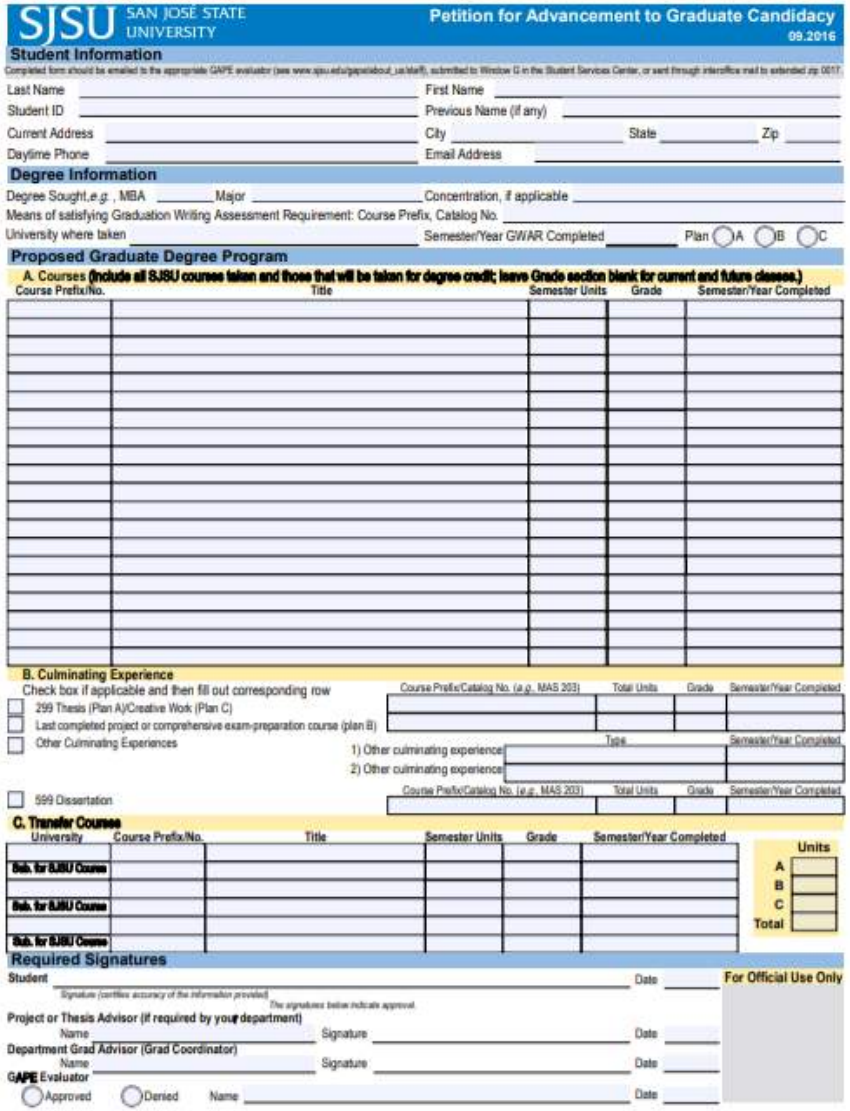
Prerequisites for ME 295 A and ME 299 Course

- Completed at lease nine-units in the program
- Classified status
- Not Conditionally classified
- Approved Candidacy form (or expected to be approved before submission of the project proposal)
- Not on probation

Project Proposal Requirements

1. Have an approved Candidacy Form

Form is available on the ME website



SJSU SAN JOSÉ STATE UNIVERSITY

Petition for Advancement to Graduate Candidacy

09.2016

Student Information

Completed form should be emailed to the appropriate GAPE evaluator (see www.sjsu.edu/gape/about_us/staff), submitted to Window G in the Student Services Center, or sent through interoffice mail to extended zip 0017.

Last Name _____ First Name _____

Student ID _____ Previous Name (if any) _____

Current Address _____ City _____ State _____ Zip _____

Daytime Phone _____ Email Address _____

Degree Information

Degree Sought *e.g.*, MBA _____ Major _____ Concentration, if applicable _____

Means of satisfying Graduation Writing Assessment Requirement: Course Prefix, Catalog No. _____

University where taken _____ Semester/Year GWAR Completed _____ Plan ◯A ◯B ◯C

Proposed Graduate Degree Program

A. Courses (Include all SJSU courses taken and those that will be taken for degree credit; leave Grade section blank for current and future classes.)

Course Prefix/No.	Title	Semester Units	Grade	Semester/Year Completed

B. Culminating Experience

Check box if applicable and then fill out corresponding row

	Course Prefix/Catalog No. (e.g., MAS 203)	Total Units	Grade	Semester/Year Completed
☐ 299 Thesis (Plan A)/Creative Work (Plan C)				
☐ Last completed project or comprehensive exam-preparation course (plan B)				

	Type	Semester/Year Completed
☐ Other Culminating Experiences	1) Other culminating experience	
	2) Other culminating experience	

	Course Prefix/Catalog No. (e.g., MAS 203)	Total Units	Grade	Semester/Year Completed
☐ 599 Dissertation				

C. Transfer Courses

	University	Course Prefix/No.	Title	Semester Units	Grade	Semester/Year Completed
Sub. for SJSU Course						
Sub. for SJSU Course						
Sub. for SJSU Course						

Units	
A	
B	
C	
Total	

Required Signatures

Student _____ Date _____

Signature (certifies accuracy of the information provided)

The signatures below indicate approval.

Project or Thesis Advisor (if required by your department)

Name _____ Signature _____ Date _____

Department Grad Advisor (Grad Coordinator)

Name _____ Signature _____ Date _____

GAPE Evaluator

◯Approved ◯Denied Name _____ Date _____

For Official Use Only

Project Proposal Requirements

Candidacy Form

https://www.sjsu.edu/me/docs/forms_gape-candidacy.pdf

Step-by-step Instructions for Filling out the Form

https://www.sjsu.edu/me/docs/msme_currentstudents-candidacy_form_instructions_02_05_19.pdf

Requirements

2. A completed proposal should include:

A. The Project Cover Page

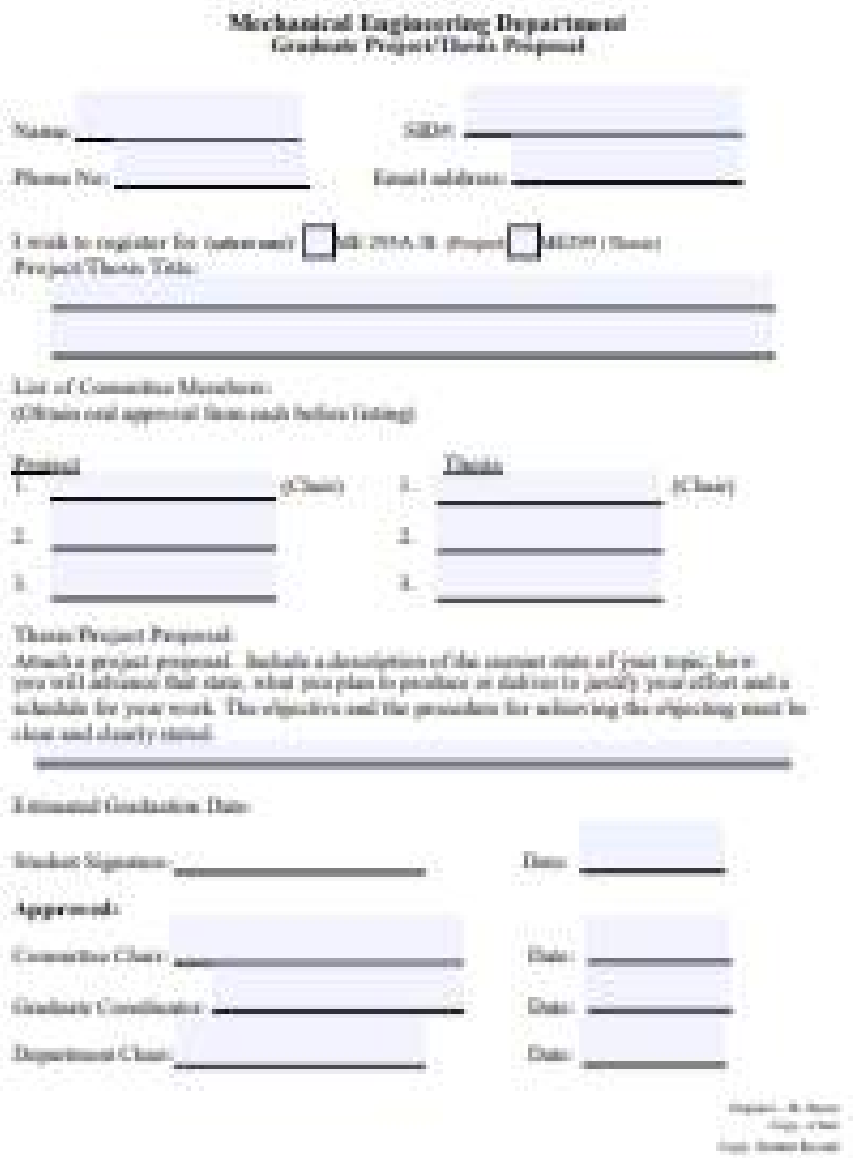
B. Approved committee evaluation

C. Approved Candidacy Form

D. A comprehensive and detailed proposal of the project

NOTE: Submit all the four items in the listed order and as one package

A. Project Cover Page



Mechanical Engineering Department
Graduate Project/Thesis Proposal

Name: _____ SID#: _____

Phone No: _____ Email address: _____

I wish to register for (please mark) ☐ ME 299A/B (Project) ☐ ME 299 (Thesis)

Project/Thesis Title:

_____

_____

List of Committee Members:
(Obtain oral approval from each before listing)

Project		Thesis	
1. _____	(Chair)	1. _____	(Chair)
2. _____		2. _____	
3. _____		3. _____	

Thesis Project Proposal:
Attach a project proposal. Include a description of the current state of your topic, how you will advance that state, what you plan to produce or elaborate to justify your effort and a schedule for your work. The objectives and the procedures for achieving the objectives must be clear and clearly stated.

_____

Estimated Graduation Date:

Student Signature: _____ Date: _____

Approved:

Committee Chair: _____ Date: _____

Graduate Coordinator: _____ Date: _____

Department Chair: _____ Date: _____

B. Committee Evaluation Form

MSME Project/Thesis Proposal Evaluation

San Jose State University – Department of Mechanical Engineering

Title:	___ Project ___ Thesis
Student Name:	SJSU ID:

Evaluators	Signature	Date
Committee Chair:		
Committee Member 1:		
Committee Member 2:		

Criterion	Committee Chair			Committee Member 1			Committee Member 2		
	As submitted	Accept after minor revisions	Unacceptable	As submitted	Accept after minor revisions	Unacceptable	As submitted	Accept after minor revisions	Unacceptable
The **title** used effective wording to communicate the purpose and scope of the study accurately.									
The **significance and impact** of the evidence were presented convincingly, and it was evident how the work benefits society or advances state-of-the-art in the topic of study.									
A sufficient **literature review** was conducted, and it revealed an understanding of relevance to the topic of study. A need that motivates the proposed project was identified.									
A clear engineering **objective statement** was stated, and it had appropriate technical rigor for graduate level study. Design or performance specifications (if applicable) were explicitly identified.									
A detailed description of the **methodology** and a realistic **implementation plan** were developed, including required resources, contingency plans, and timeline.									
Tangible **deliverables** were stated explicitly, in a way that can be objectively measured.									
Wording style, grammar, and spelling were used appropriately for graduate-level technical **writing**.									
The proposal complied with all **format requirements** as stated in the MS 265/298 proposal guidelines.									
Overall, the proposal established high confidence that the evidence will be completed successfully.									

Step-by-step Instructions for Submitting the Proposal

- **https://www.sjsu.edu/me/docs/forms_msme-DocuSign_MSME%20Project_Thesis%20Proposal_Procedures_090221Rev.pdf**

Submit your proposal to the ME office

3. Have the Proposal Ready

A proposal is considered complete when Signed by:

1. *Your committee Chair*
2. *The Graduate Advisor*
3. *The department Chair*

4. Post-Proposal Requirements

Meet regularly with the committee Chair and the committee members and have them sign the meeting-record form, shown on the next page

Adviser meeting-record form

Mechanical Engineering Department
Graduate Student Thesis/ Project Committee Chair and Members
Consultation Records

Graduate students enrolled in Project/Thesis courses are expected to meet with their study committee chairs a minimum of four (4) periods during each semester, preferably, on a monthly basis and at least one meeting with each committee member. Please be sure to take this sheet to your meetings with your study Committee Chair and Members and request acknowledgement.

Date: _____ Time: _____ Committee Chair Signature: _____

Date: _____ Time: _____ Committee Chair Signature: _____

Date: _____ Time: _____ Committee Chair Signature: _____

Date: _____ Time: _____ Committee Chair Signature: _____

Date: _____ Time: _____ Committee Member Signature: _____

Date: _____ Time: _____ Committee Member Signature: _____

Date written draft report received by the Committee Chair: _____ Date: _____

Students are expected to give this sheet to the Committee Chair on their presentation day.

Student Name: _____

5. Oral Presentation

Make an Oral Presentation:
(Dead day of Classes)

NOTE: This is scheduled by the ME office

5. Oral Presentation

Before the Oral presentation:

Submit a final draft of the final report to your committee members

Deliverables

1. Midterm Report: Check with your committee chair

2. Oral Presentation

3. Final Report (draft): Before you make the Oral presentation

4. Advisory committee consultation form

4. Final Report: For due date, check with your Committee Chair

How to Arrange for the Oral Presentation?

Contact the ME office to schedule your oral presentation. The ME office will contact your advisory committee and schedule your presentation.

How to Add ME 295 A or ME 299

- You must have an **approved** proposal to get an add code.
- After the proposal is fully approved, ask your committee chair for an add code for the course
- No Pre-registration allowed

Important dates and Deadlines

This Semester:

- **April 28, 2023**
  - *Project Initiation Meeting*
- **April 28, 2023, through May 15, 2023**
  - *1. Search for Possible Projects*
  - *2. Contact ME Professors and select a Committee Chair*
  - *3. Form the advisory committee*
  - *4. Conduct a literature search on the project-topic and prepare a draft of the project proposal.*

Important dates and Deadlines

Next Semester

- **August 21, 2023, through September 8, 2023:**
  - *Finalize the draft of the project proposal*
  - *Have the proposal approved by the advisory committee*
  - *Be ready to submit the proposal to the department office*

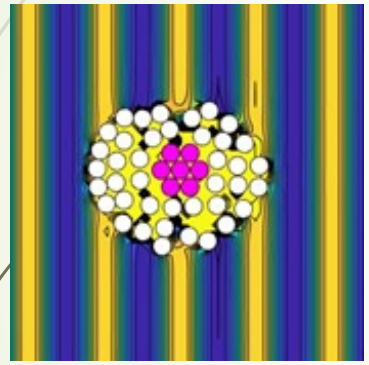
- **September 8, 2023:** *Submit the approved proposal to the ME office, for approval by the Graduate Advisor and the department Chair*

- **September 15, 2023**: ***University Deadline for adding a course***

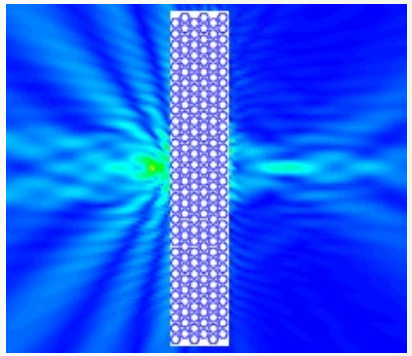
Note

When your proposal is approved by the ME office, you can obtain the add code from your committee chair.

Available Projects



Research Interests and Proposed TopicS



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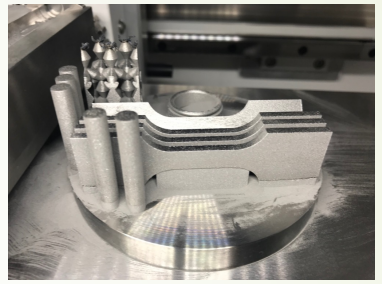
Department of Mechanical Engineering
San Jose State University

April 28 2023

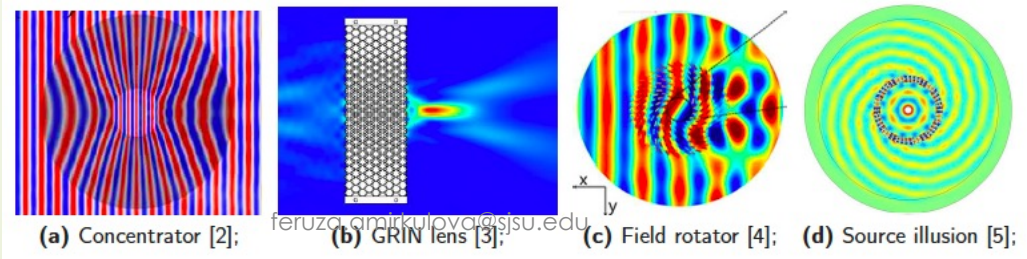
Inverse Design, Manufacturing, and Testing of Acoustic and Elastic Metamaterials

- Design of broadband Acoustic and Elastic Metamaterials using generative neural network, global based optimization, and reinforcement learning
- Manufacturing of Metamaterials using selective laser melting (SLM) metal additive manufacturing system
- Testing of Metamaterials and metaclusters using sound & vibration analyzer platform from Brüel & Kjær
- Through the projects, the students are expected to gain practical experience in metamaterial design, manufacturing, and testing and be familiar with:
  - Julia and MATLAB programming, including various Toolboxes;
  - TensorFlow and PyTorch Python libraries, high performance computing on COE HPC cluster and Multi-GPUs ;
  - Developing deep reinforcement learning, deep learning and generative network models
  - Numerical simulation tool such as COMSOL Multiphysics;
  - Sound pressure level measurements and vibration testing using state-of-the-art sound & vibration analyzer platform from Brüel & Kjær, LDS control system, and BK connect software;
  - Selective laser melting metal additive manufacturing system (NSF-MRI award) , and 3D printing.



Our first build using EOS SML system

Forward and inverse design of pentamode metamaterials (optimization, DL, RL, COMSOL simulations) and Transformation acoustics devices



(a) Concentrator [2]; (b) GRIN lens [3]; (c) Field rotator [4]; (d) Source illusion [5];

The examples of transformation acoustics devices.

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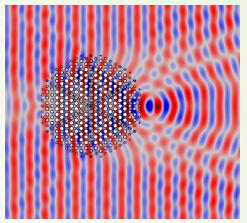
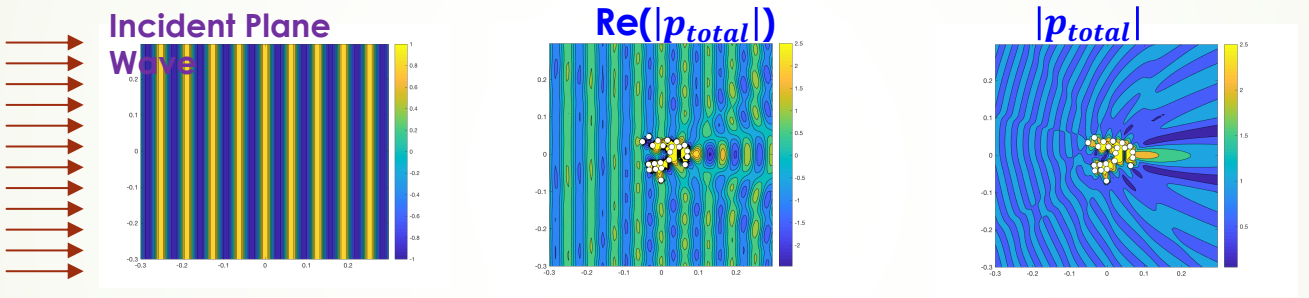
Design of some other devices



- Acoustic lens design: Maximizing sound pressure amplitude at focal point

$ka = 0.75, a = 0.0075m,\ \boldsymbol{x}_f = (R_2 + 5 * a),\ M = 22,$ Final optimized configuration



Amirkulova et al. (*JASA*, 143(3), 2018)

- 3D Volume Sound Diffusers: Maximizing the diffusivity coefficient
- Positioning of offshore floating structures: Minimizing the scattered wave energy and wave drift force
- Optimized 2D and 3D multilayered metamaterials and phononic crystal structures can be realized by defining the gradients WRT to thickness

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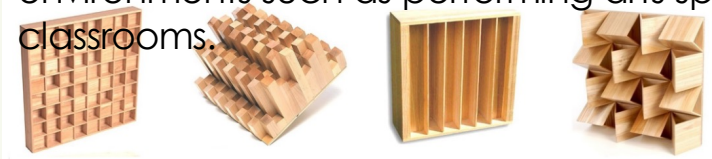
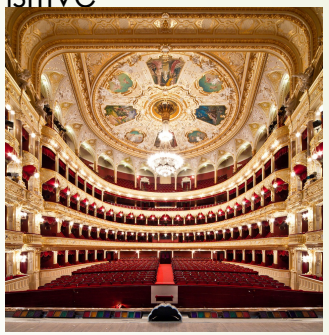
Sound Diffusers

Diffusers are a type of acoustic treatment installed in acoustically sensitive environments such as performing arts spaces, concert halls, and classrooms.

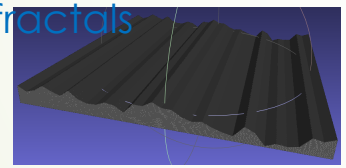




Examples of different types of geometric diffusers.

Examples of fractals in nature

RMD stochastic fractals



Fractal surfaces are virtually generated with a different roughness parameter

MOTIVATION:

Design of geometric sound diffusers

Frequency-invariant scattering is needed in these spaces because the human ear is sensitive across a broad frequency range (20 to 20LHz). Diffusers with fractal geometries can theoretically provide such scattering because they exhibit self-similarity at different dimensional scales.

Design of volume sound diffusers

Unlike the traditional surface diffusers, placing the scatterers in the volume of the room may provide greater efficiency by allowing the scattering into the whole space in all possible directions

Students will Perform numerical simulations, manufacture the diffusers, and measure sound pressure level using state-of-the-art sound & vibration analyzer platform from Brüel & Kjær.

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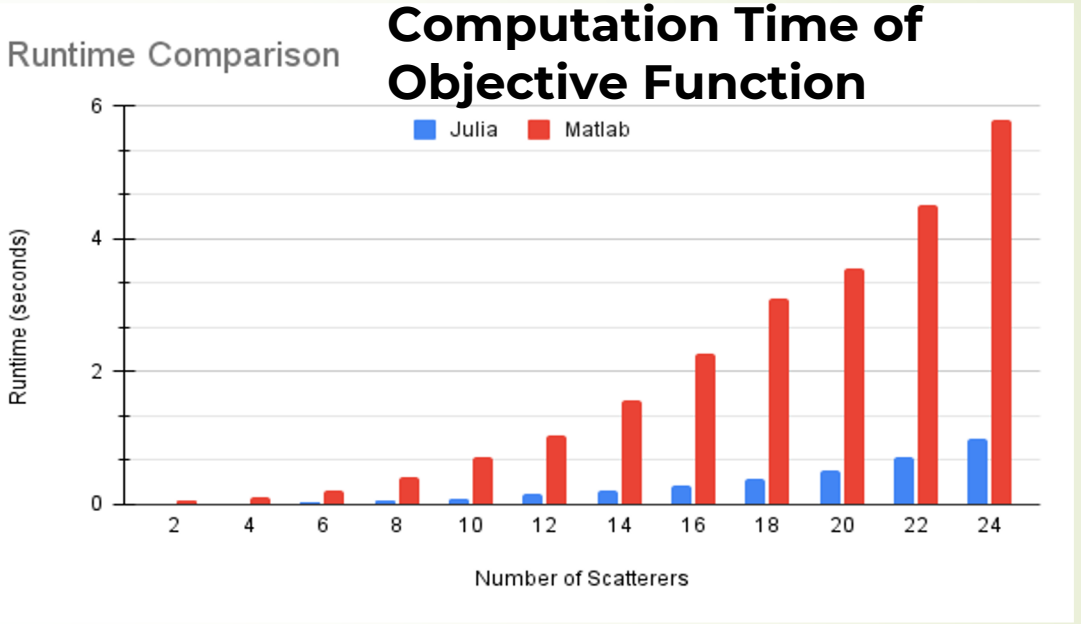
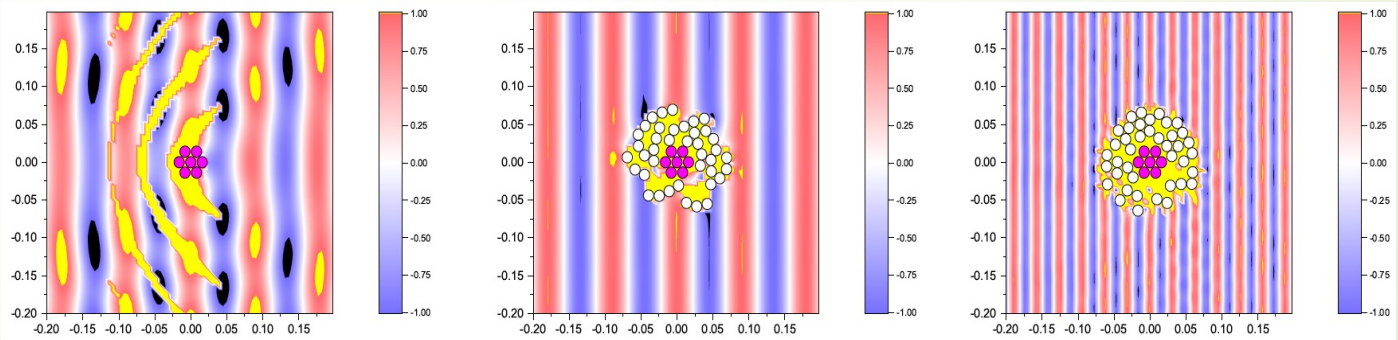
Design of Metamaterials Using Gradient Based Optimization

- Julia programming



Cloaking [1] with $M = 47 cylinders$: minimizes TSCS, σ, at single wavenumber $ka = 0.525; 1.5$.



(a) No cloak: $\sigma = 0.12595$ (b) $ka = 0.525, \sigma_r = 1.4106e-04$ (c) $ka = 1.5, \sigma_r = 0.0126$

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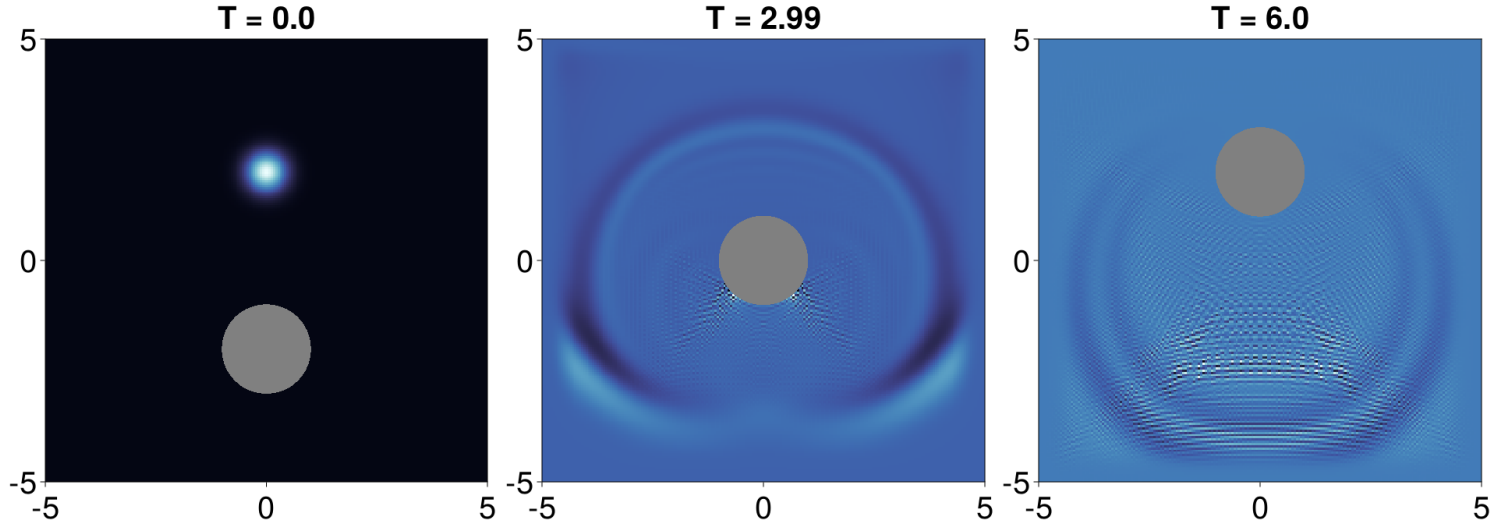
Design of Metamaterials Using Model Predictive Control

- Four-dimensional acoustics using time-varying metamaterials
- Julia programming



Proposed Topics by F. Amirkulova

Design of Metamaterials, Meta-devices and Hearing Aids using Optimization, Deep Learning and Reinforcement Learning and Performing Sound Measurements:

- **Inverse Design of Acoustic Metamaterials using Generative Neural Networks (WGAN and VAE)**
- **Design of Metamaterials Using Deep Learning (DL) and Model-free Deep Reinforcement learning (RL)**
  - Inverse design of Volume Sound Diffusers using neural networks (DL,RL)
  - Inverse design of 3D multilayered metamaterials using Deep Learning (DL) (DL,RL, recurrent neural networks)
  - Inverse design of 2D multilayered metamaterials using Deep Learning (DL)(DL,RL, recurrent neural networks)
  - Inverse design of 3D multilayered metamaterials via gradient based optimization and sound measurements
  - Design of pentamode metamaterials and Transformation Acoustics devices (optimization, DL, RL, COMSOL simulations)
- **Design of Metamaterials Using Model Predictive Control (Julia programming)**
- **Design of Metamaterials Gradient Based Optimization Algorithms (Julia programming)**
- **Investigation of human directional hearing in a semi-anechoic environment**
- **AI assisted accessibility projects and hearing aids**
  - Develop novel innovative techniques for design of hearing aids using optimization, and artificial intelligence algorithms, including deep learning, reinforcement learning, and generative modeling

ME-231: Machine Learning and Optimization in Mechanical Engineering offered in FALL 2023

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EXTRA

Our Recent Publications

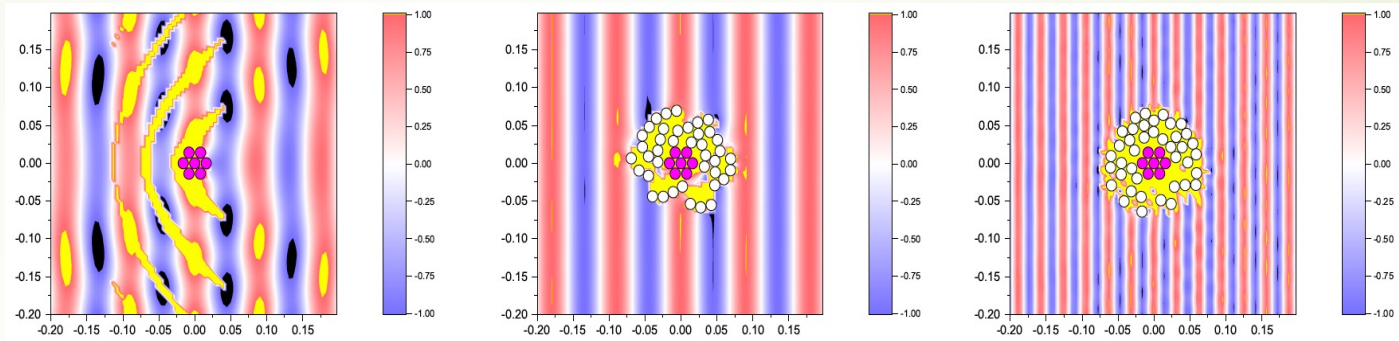
Metamaterials Through Multi-scattering and Gradient-based Optimization

- **Acoustic cloak**

Acoustic cloak renders an object invisible to incident waves

Optimize TSCS

Cloaking [1] with $M = 47 cylinders$: minimizes TSCS, σ, at single wavenumber $ka = 0.525; 1.5$.



(a) No cloak: $\sigma = 0.12595$ (b) $ka = 0.525, \sigma_r = 1.4106e-04$ (c) $ka = 1.5, \sigma_r = 0.0126$

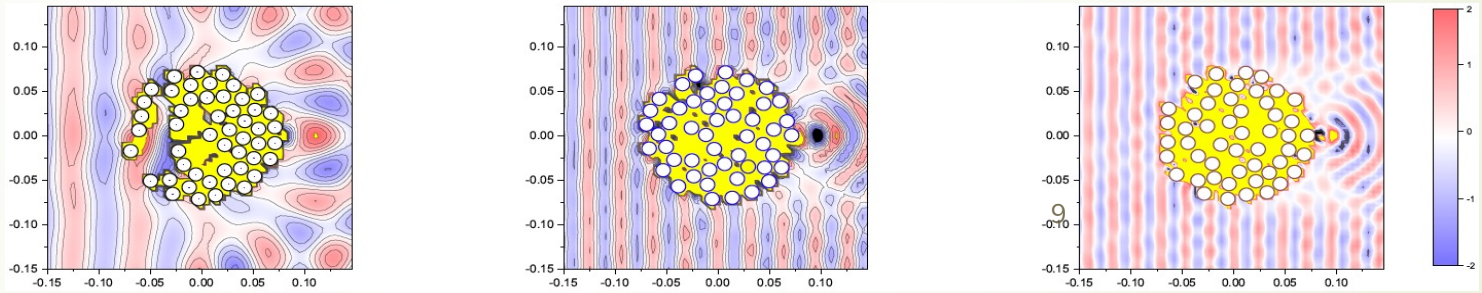
Amirkulova & Norris. The Gradient of Total Multiple Scattering Cross-Section and Its Application to Acoustic Cloaking. *JTCA* 2020: 1950016. doi: 10.1142/s2591728519500166

- **Sound Localization**

Acoustic lens focuses the incident plane wave on the other side of lens

Optimize pressure at focal point $|p_f|$

Sound Localization [2] with $M = 50\ cylinders$: maximizes $|p_f|$, at wavenumbers $ka = 0.75; 1.5\ and\ 2$.



a $ka = 0.75$ **b** $ka = 1.5$ **c** $ka = 2$

Amirkulova, Gerges, & Norris. Sound Localization Through Multi-scattering and Gradient-based Optimization (Mathematics, 2021)

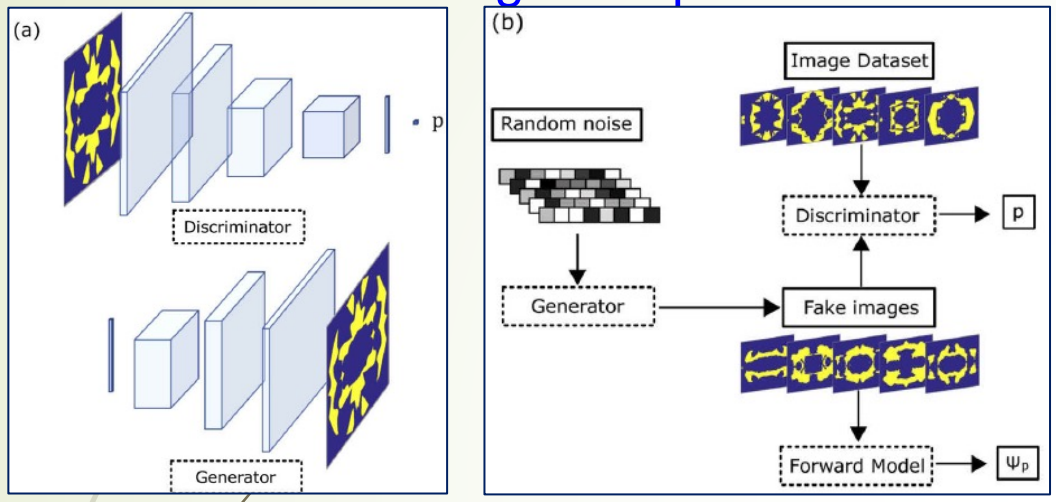
- **Sound Diffusers**

Optimize diffusion coefficient d_ψ

N. Shah & F. Amirkulova. 1aAA2: Broadband Optimization of Volumetric Sound Metadiffusers. ***AiF, ASA Spring Virtual Meeting, June 8, 2021***

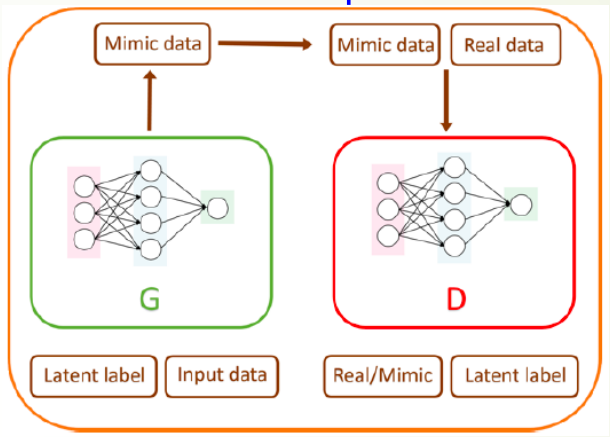
Applications of Generative Adversarial Networks (GAN)

GAN for design of optical cloak



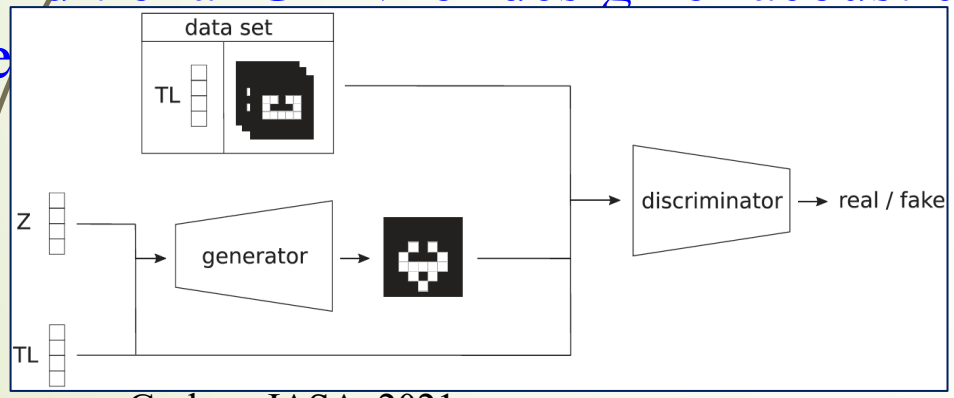
Blanchard-Dionne & Martin, OSA Continuum 2020.

Conditional WGAN for protein solubility prediction



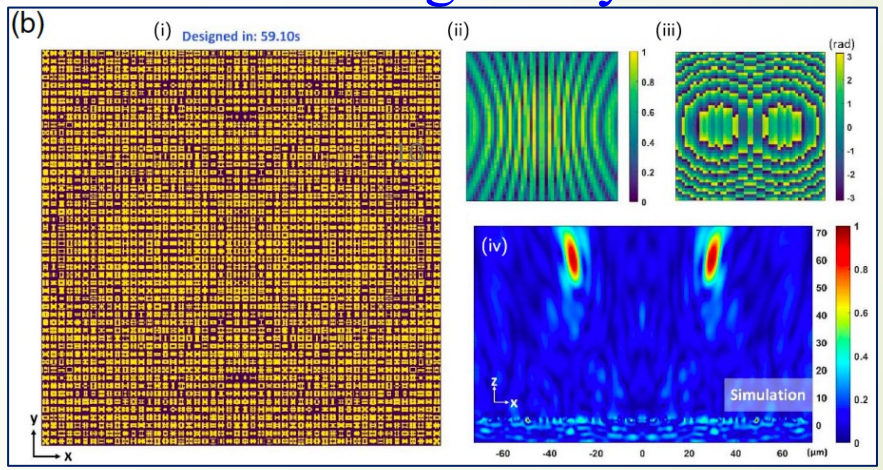
Han et al. InfoMat 2020

Conditional GAN for design of acoustic me



Gurbuz, JASA, 2021

Double-focus flat lens designed by conditional WGAN



An et al., Advanced Optic. Mater. 2021

Our Recent Publications

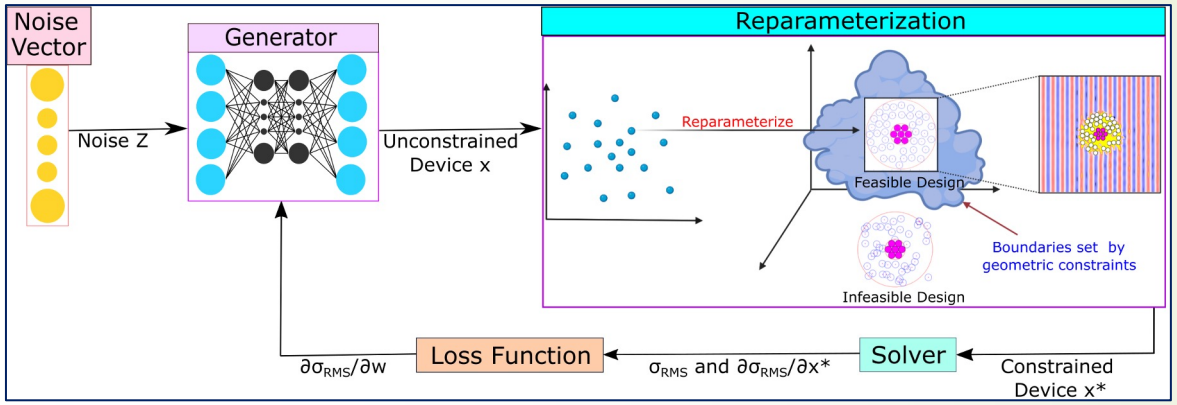
2D-GLOnets Model Based Generative Modeling and Gradients

Noise Vector

- Gaussian Noise

Generator

- Fully Connected layers
- LeakyRelu
- Tanh for output layers



Solver

- In-house built multiple scattering solver that computes objective function and gradients g
- Implemented on PyTorch Python libraries calling MATLAB engine from Python

Loss Function

- Search and refine the optimized design space

Algorithm 1: Training Process of 2D-GLOnets

Parameters: α, learning rate. ϕ, generator parameters. Adam, Adaptive Moment Estimation (ADAM)

initialization

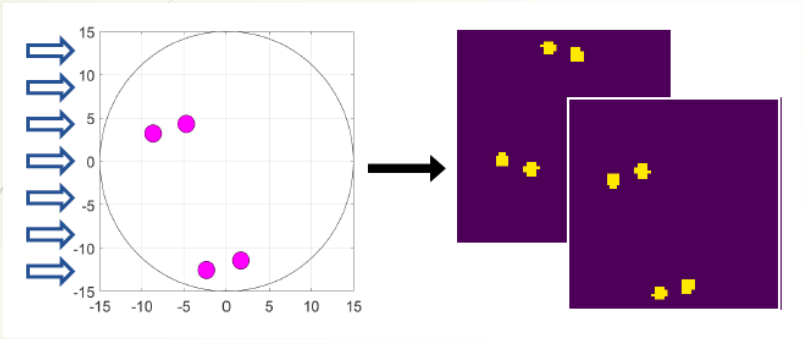
while $i <$ *total iterations* **do**

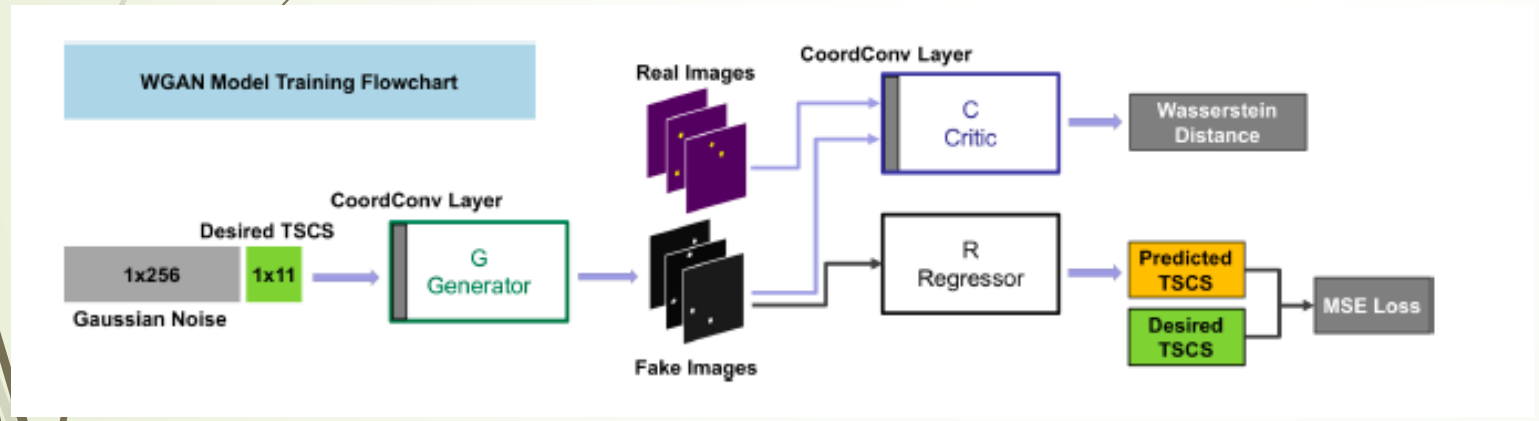
- sample $\{z^k\}_{k=1}^{K} \sim \mathcal{U}(0, 0.2)$
- generate $\{x^k = G_\phi(z^k)\}_{k=1}^{K}$
- reparameterize $\{x^* = \epsilon(x^k)\}_{k=1}^{K}$
- compute $\{q_j^k\}_{k=1}^{K}, \{\sigma_{RMS}^k\}_{k=1}^{K}$
- update $\phi \leftarrow \phi + \alpha \cdot \text{Adam } L(x, g_\epsilon, \sigma_{RMS})$

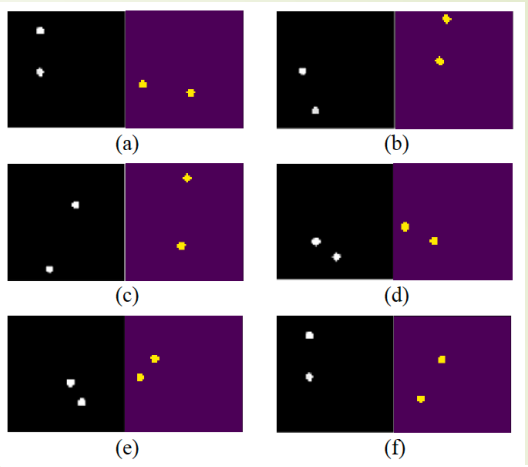
end

Zhuo* L., & Amirkulova, F. (2021). Design of Acoustic Cloak Using Generative Modeling and Gradient-Based Optimization. InterNoise21, Washington, D.C., USA, 263(3), 3511–3522, **2021** https://doi.org/10.3397/in-2021-2431

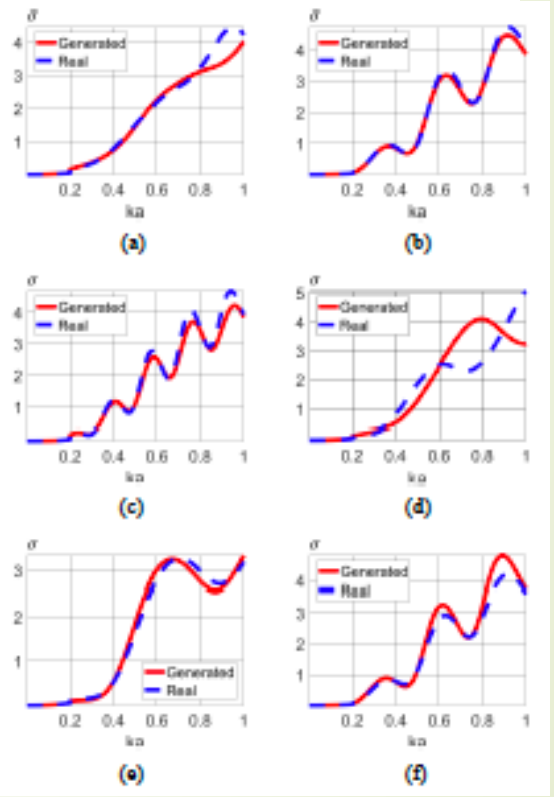
Our Recent Publications
Conditional WGAN model







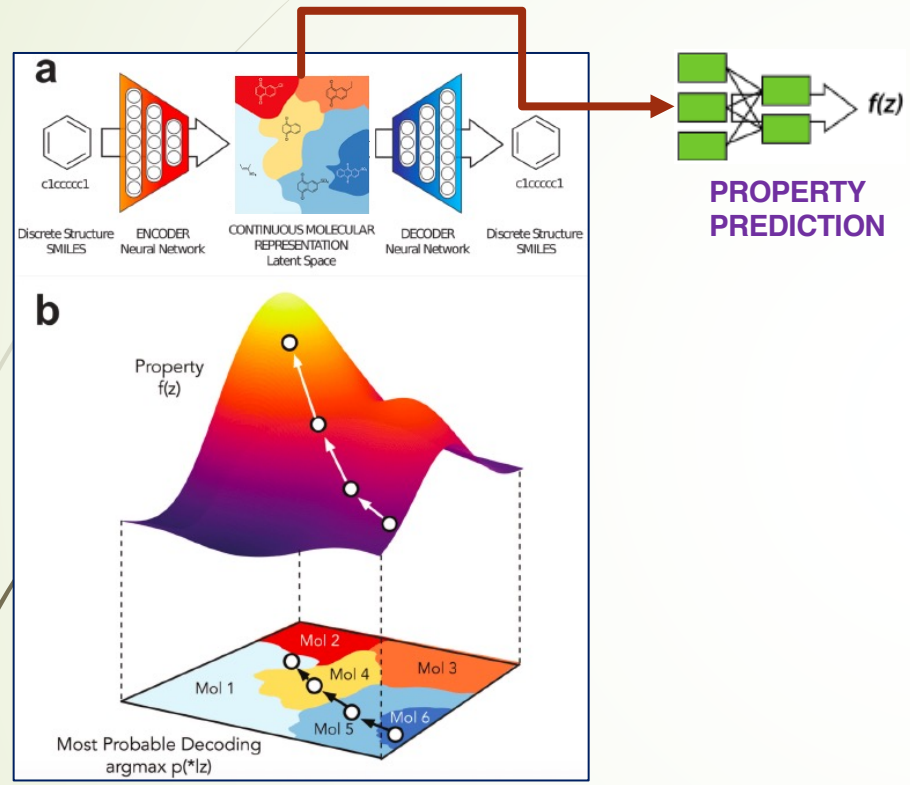
TSCS



Lai* P., **Amirkulova F.**, Gerstoft P. Conditional Wasserstein Generative Adversarial Networks Applied to Acoustic Metamaterial Design. *J. Acoust. Soc. Am*, accepted 2021

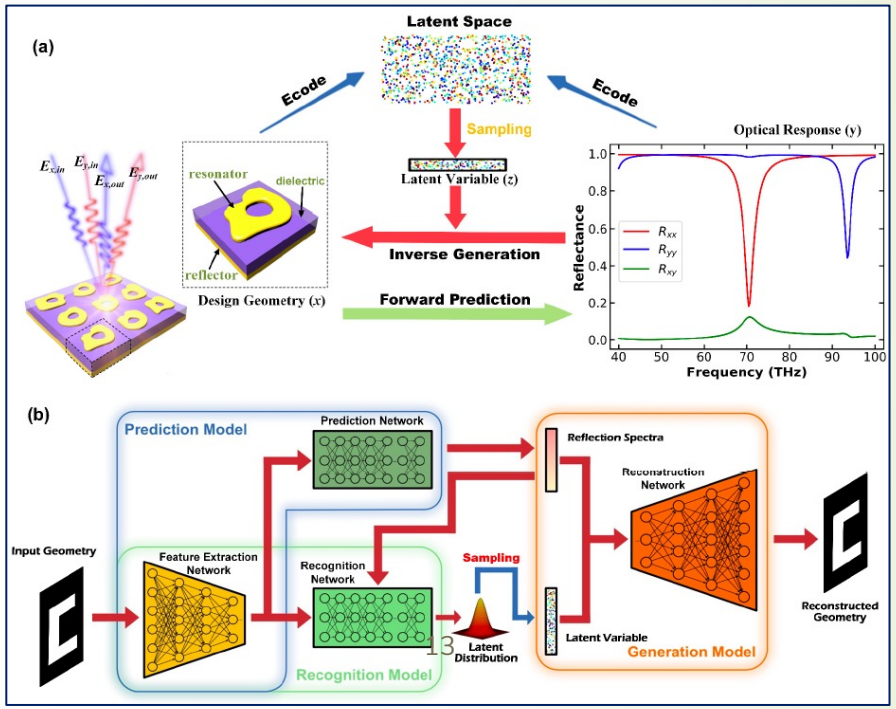
Applications of Variational Autoencoders (VAE)

Application of a VAE to chemical design:



Gómez-Bombarelli et al. ACS Cent. Sci. 2018

Application of VAE and semi-supervised learning to optical metamaterial design:



Ma et al. Adv. Mater. 2019

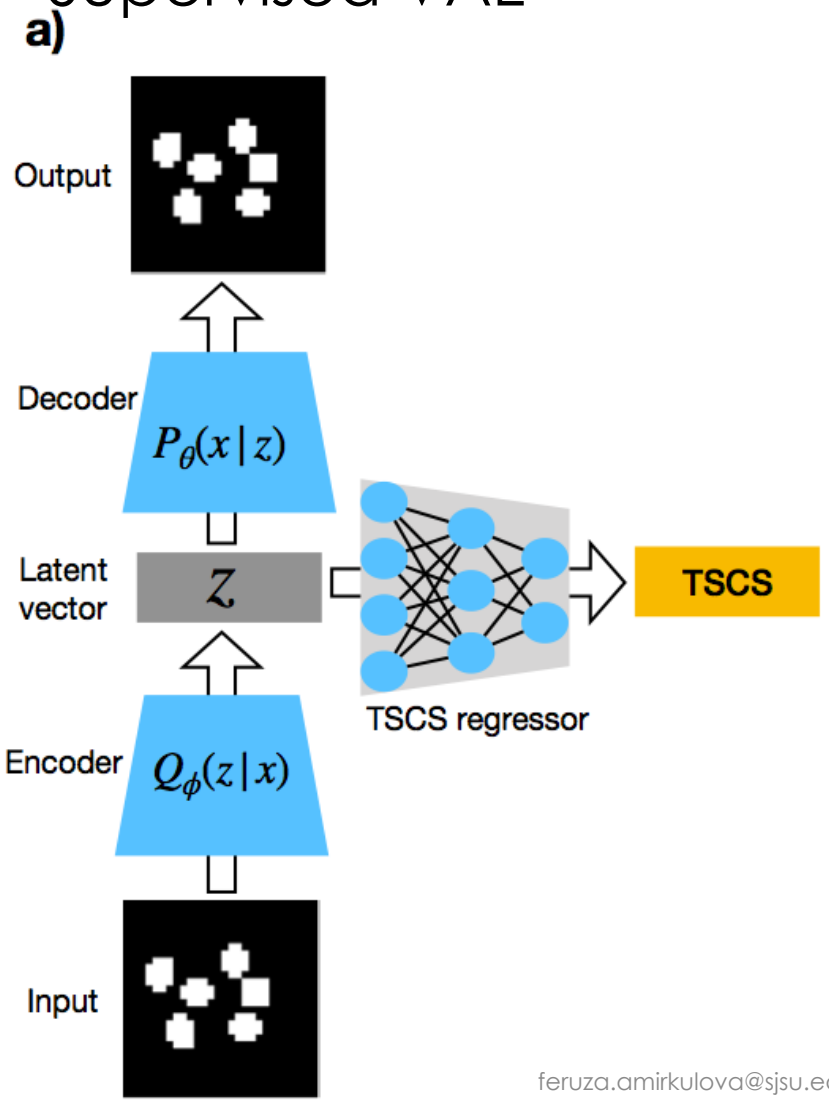
Application of CNN and VAE to acoustic metamaterial design:

T. Tran et al. 3aSA6: Total multiple scattering cross section evaluation using convolutional neural networks for forward and inverse designs of acoustic metamaterials. ***AiF, ASA Spring Virtual Meeting, June 10 2021***

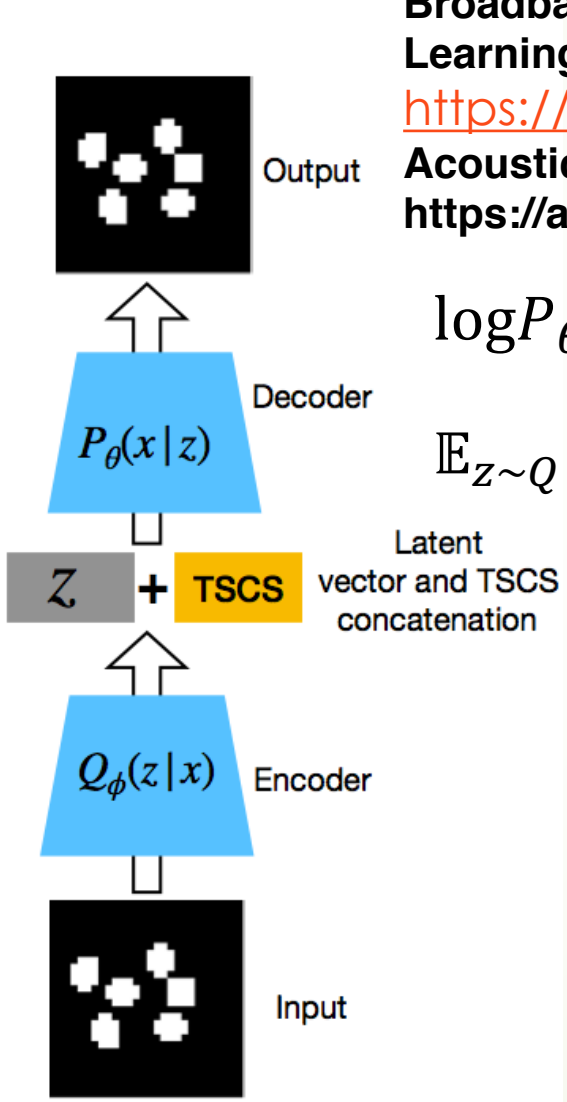
Variational Autoencoder (VAE) Design

Our Recent Publications

Supervised VAE



Conditional VAE



Thang Tran, Feruza Amirkulova and Ehsan Khatami

Broadband Acoustic Metamaterial Design via Machine Learning (accepted 2022, JTCA)

https://doi.org/10.1142/S2591728522400059

Acoustic Cloak Design via Machine Learning, 2021

https://arxiv.org/abs/2111.01230

$$\log P_\theta(x) - D_{KL}(Q_\phi(z|x)|P_\theta(z|x)) =$$

$$\mathbb{E}_{z\sim Q}[\log P_\theta(x|z)] - D_{KL}(Q_\phi(z|x)|P_\theta(z))$$

$$\mathcal{L}_{SVAE} = \mathcal{L}_R + \mathcal{L}_{KL} + \mathcal{L}_{TSCS}$$

14

$$\mathcal{L}_{CVAE} = \mathcal{L}_R + \mathcal{L}_{KL}$$

feruza.amirkulova@sjsu.edu

Our Recent Publications

Shah* T., Zhuo* L., Lai* P., De La Rosa-Moreno*^‡ A., **Amirkulova F.**, Gerstoft P. Reinforcement learning applied to metamaterial design. *J. Acoust. Soc. Am.*, 150(1), July **2021**

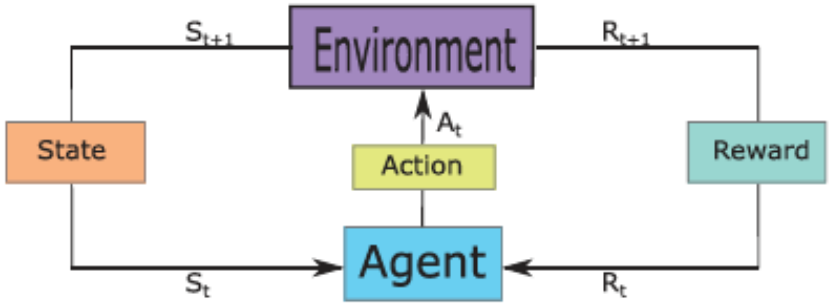
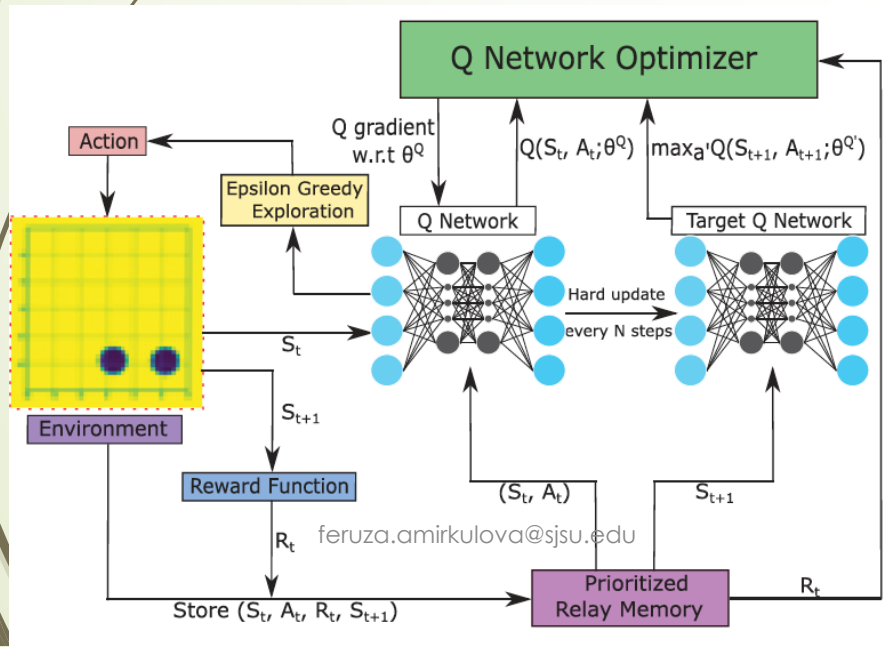
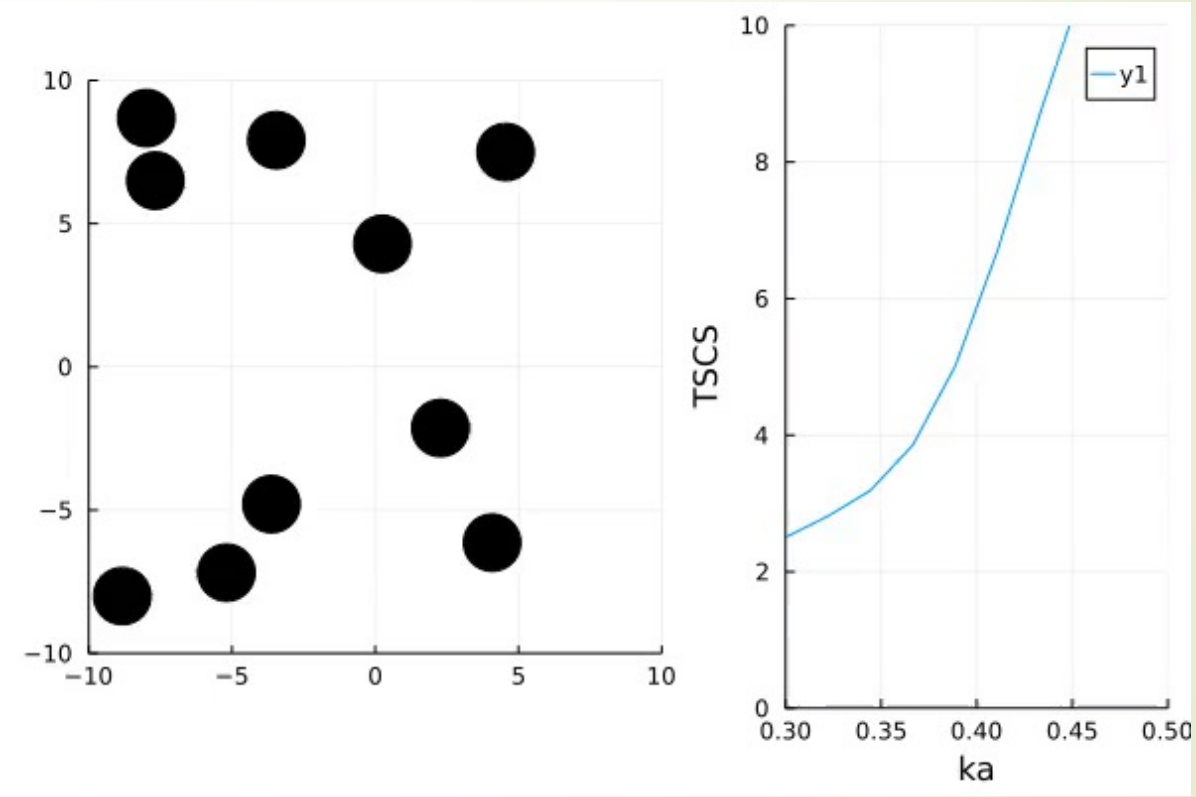


FIG. 1. (Color online) Agent interacting with environment in a MDP.

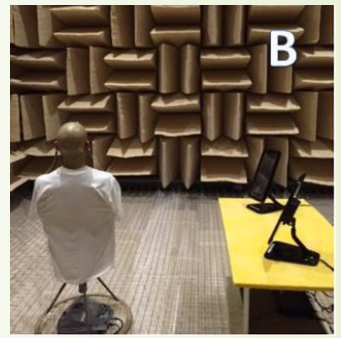


feruza.amirkulova@sjsu.edu

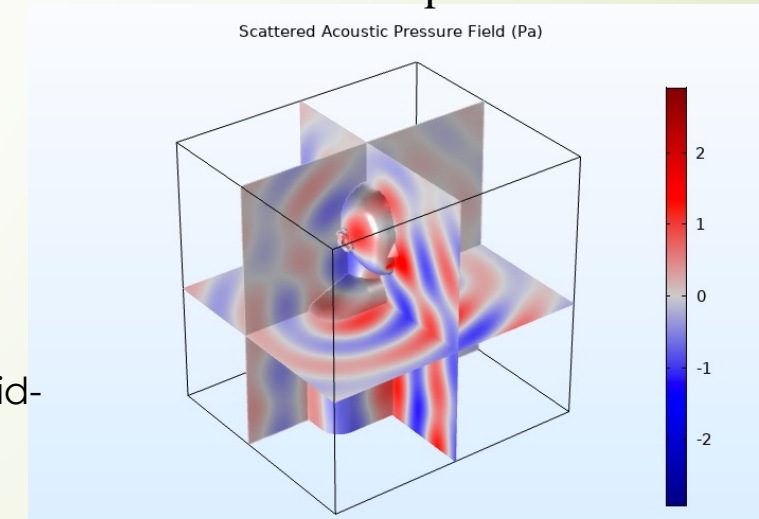


Investigation of human directional hearing in a semi-anechoic environment

- Conduct a research on developing devices and methodology that are meant for improving hearing, including hearing aids and providing sound settings that lead to improved sound quality and greater listening comfort.
- AI assisted accessibility projects on hearing aids.
- Modeling head and torso interference and extrapolation to listening environments:
  - Construct a model to simulate an acoustic field impinging on a simulated average head and torso. This model presents a generic Head and Torso Simulator and showcases some of the post-processing methods of the effects of effects of the head and torso on the pressure level gain at the ear. The simulation will be built to incorporate ear-level microphone measurements as will take place in the physical model.
  - Analyze the Acoustics of a Head and Torso Simulator on COMSOL.
  - Measure the Performance of Acoustic Devices for the Human Ear performing simulations and experimental testing in Anechoic chamber.
- Develop novel innovative techniques for design of hearing aids using optimization, and artificial intelligence algorithms, including deep learning, reinforcement learning, and generative modeling



A mannequin test



References:

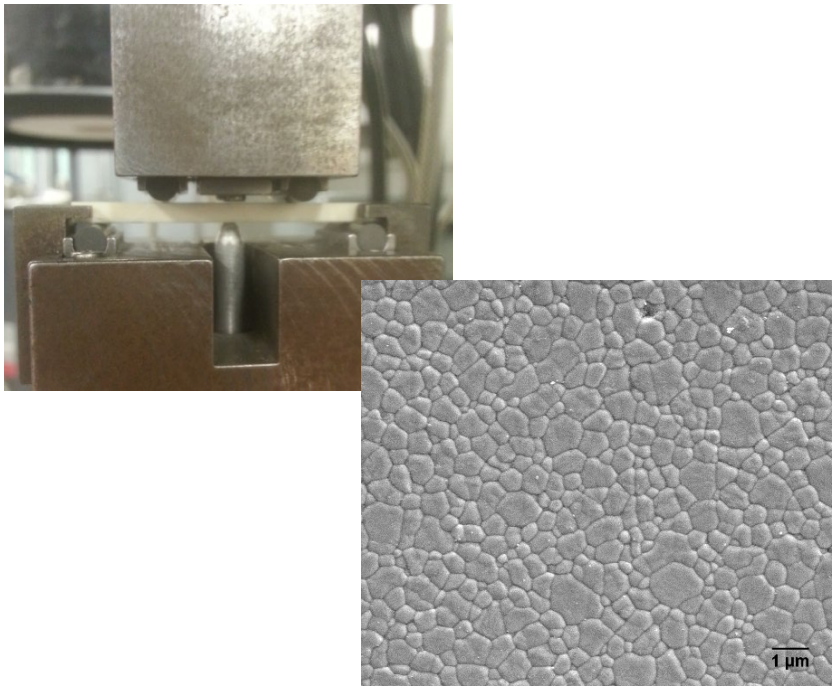
1. Gary Dagastine. On the Cutting Edge of Hearing Aid Research. COMSOL News 2017. https://spectrum.ieee.org/consumer-electronics/audiovideo/on-the-cutting-edge-of-hearing-aid-research

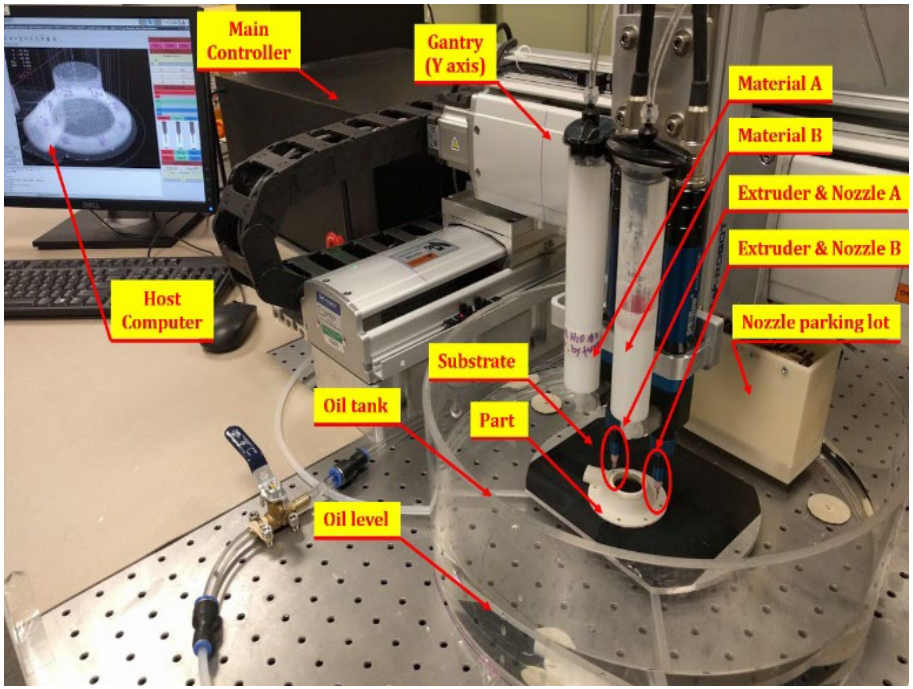
2. https://www.comsol.com/blogs/analyzing-the-acoustics-of-a-head-and-torso-simulator/

feruza.amirkulova@sjsu.edu

AM & Material Characterization

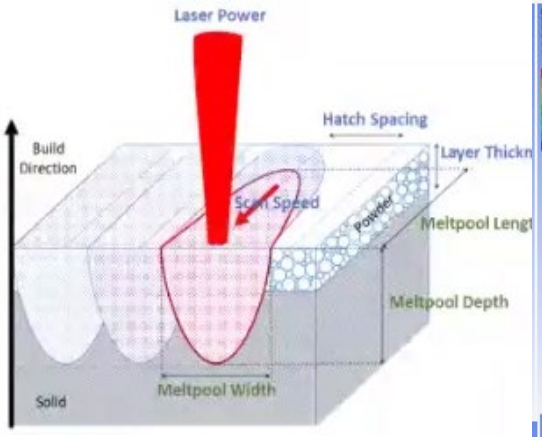
- **Experimental** project
- Novel AM process
- Supported by Lam Research Corporation

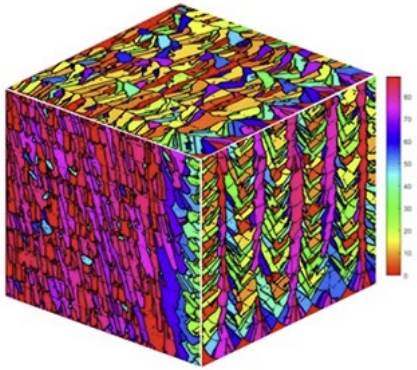


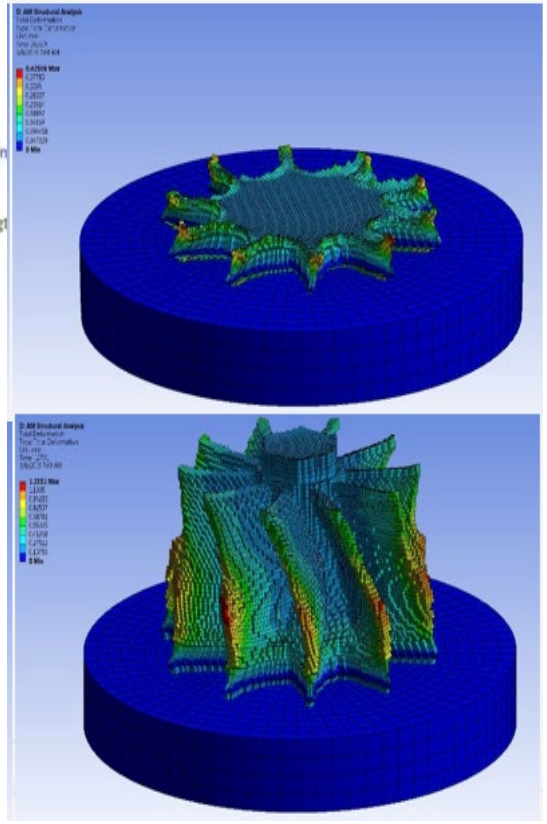


Simulation of Superalloy 3D Printing

- **Numerical** project with ANSYS
- Thermal residual stress
- Optimization

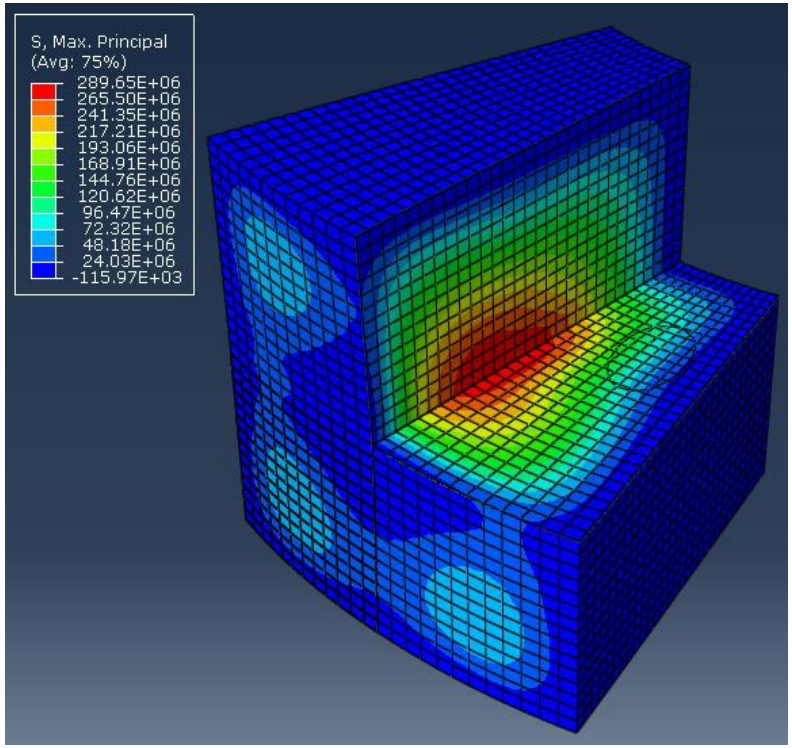


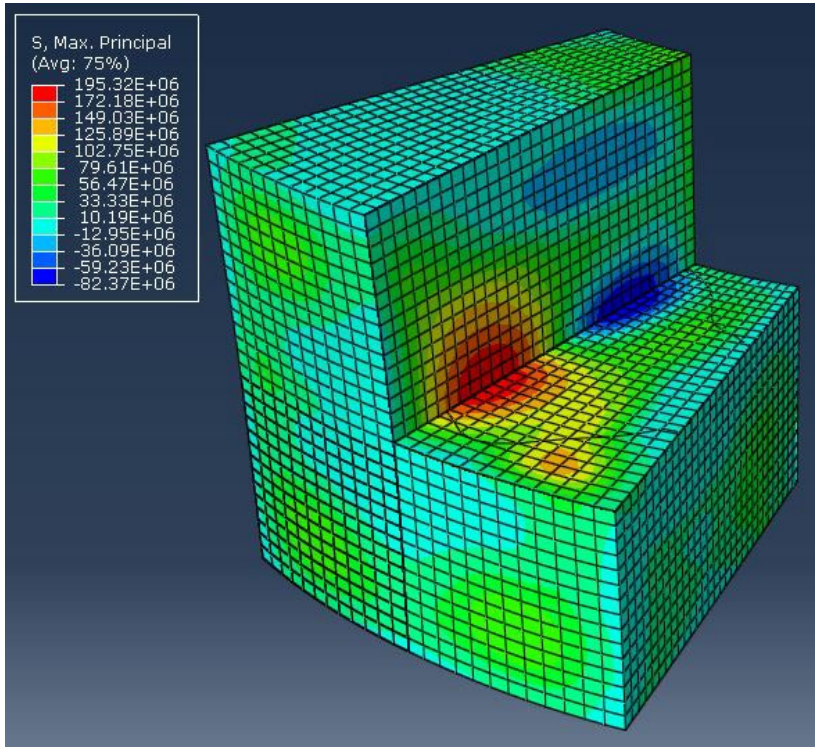




Design of FGM for 3D Printing

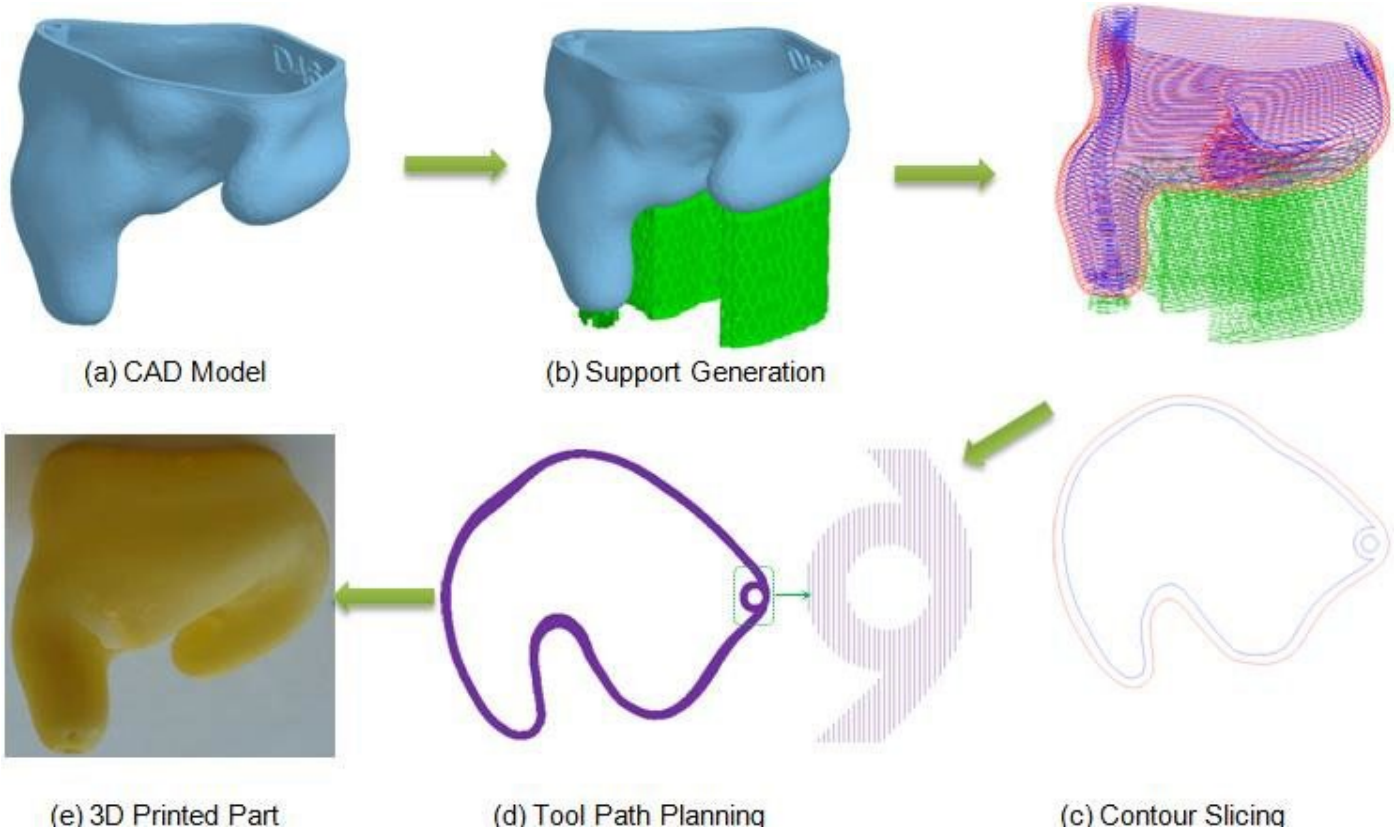
- **Numerical** project with ANSYS & MATLAB
- Material distribution can be optimized





Tool-path Planning for 3D Printing

- **Experimental and theoretical** project
- Improving the productivity and/or accuracy of AM system



Other Projects

If you have an idea, we can talk about it!

Amir Armani

amir.armani@sjsu.edu

ME295 – Available MS Projects

Winncy Du

Spring 2023

Hydrogen Characteristic Study

- Massive shootings occurred -- big concern in the nation;
- Cost for detecting/treating is very high
- Reliable diagnosis methods/uncover hidden or silent brain diseases
- Brain filtering function; bone conduction

Hydrogen Leak Detection & Data Analysis

Possible Funding & Collaborations: DOE, NREL, Shell.

Student#1 will focus on:

- Hydrogen characteristic study and its role in H2 fuel cell cars
- Ortho- and para-hydrogen gases chemical structure
- Modelling and simulation using machine learning

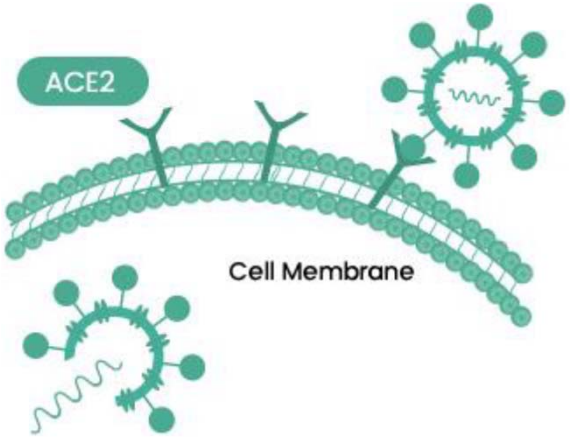
Student#2 will focus on:

- Hydrogen leak detection technologies
- Hydrogen leak detection using SPEC sensors
- Sensor data acquisition system setup
- Sensor data conditioning and analysis

Student#3 will focus on:

- Hydrogen related testing systems
- Performing testing in National Renewable Energy lab, Shell company under different conditions
- Test results analysis

Development of Biosensors



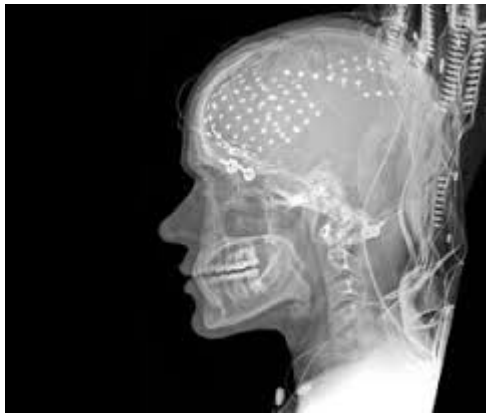
Develop a specific biosensor to address one of common issues (e.g., toxin)

- Study the issue and possible detection algorithms
- Design and build the biosensor
- Test the sensor

Wearable Sensor Array for Brain Research and Mental Disorder Diagnosis

- Massive shootings occurred -- big concern in the nation;
- Cost for detecting/treating is very high
- Reliable diagnosis methods/uncover hidden or silent brain diseases

Brain filtering function; bone conduction



Neuroscience

- Neuron activities

Mechanical Engineering

Experiment setup

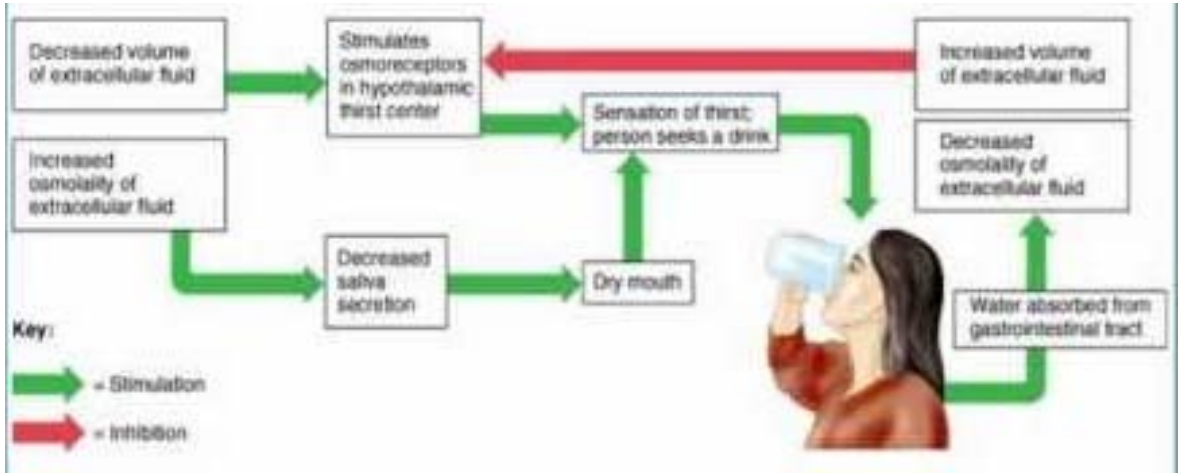
- Acoustic chamber
- Material selection
- Ultrason/Acoustics sensors

Electrical & Computer

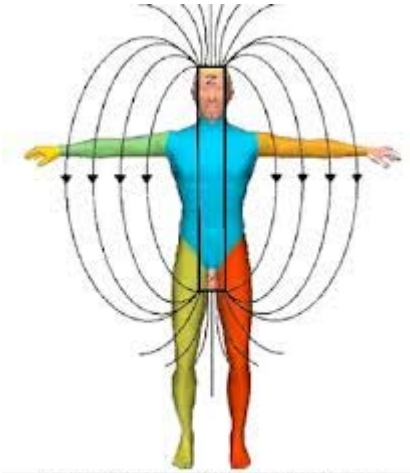
- Testing circuitry
- Interface
- Data acquisition
- Programming
- Control

Study on Human Body's Operation Mechanism or Feedback Control System

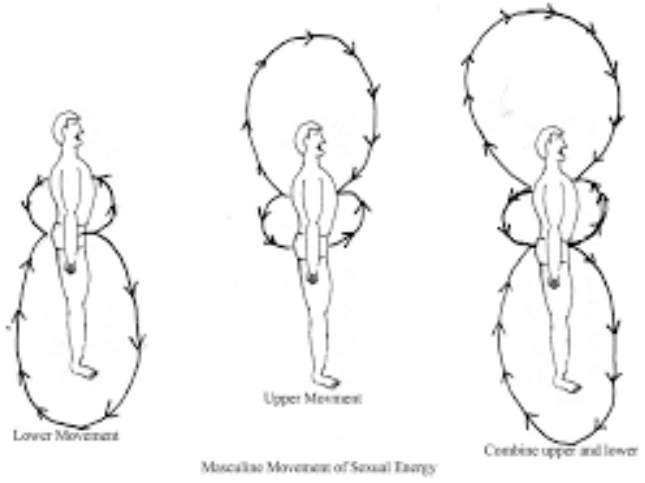
- Binary feature of human body
- Minimum energy strategies
- Feedback control system
- Thermo/Cooling mechanisms of human body
- Electrical, magnetic, and other properties

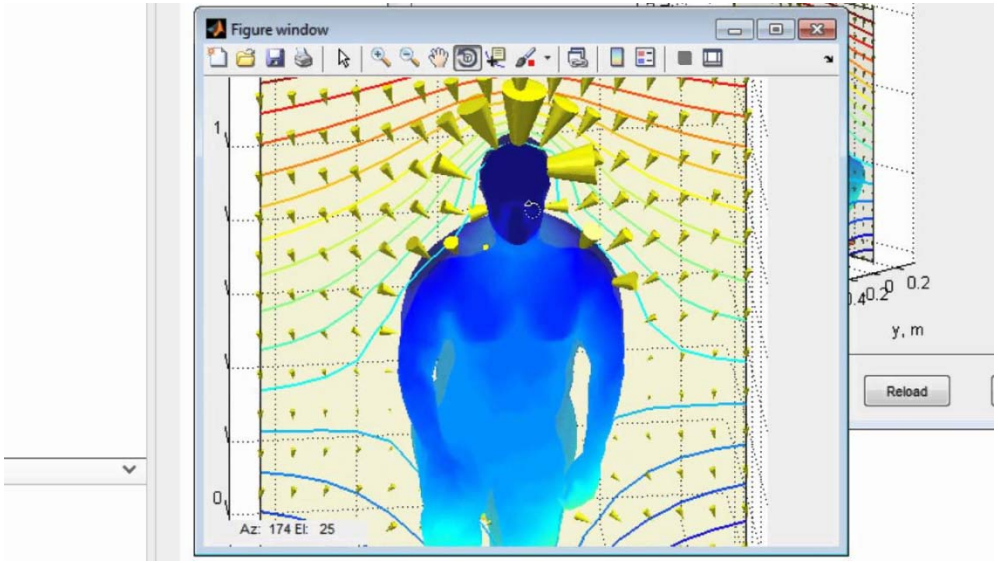


Study of Human Body based Electrical and Magnetic Features



- Mapping the electrical or magnetic field of Human body
- Their relationship with the health

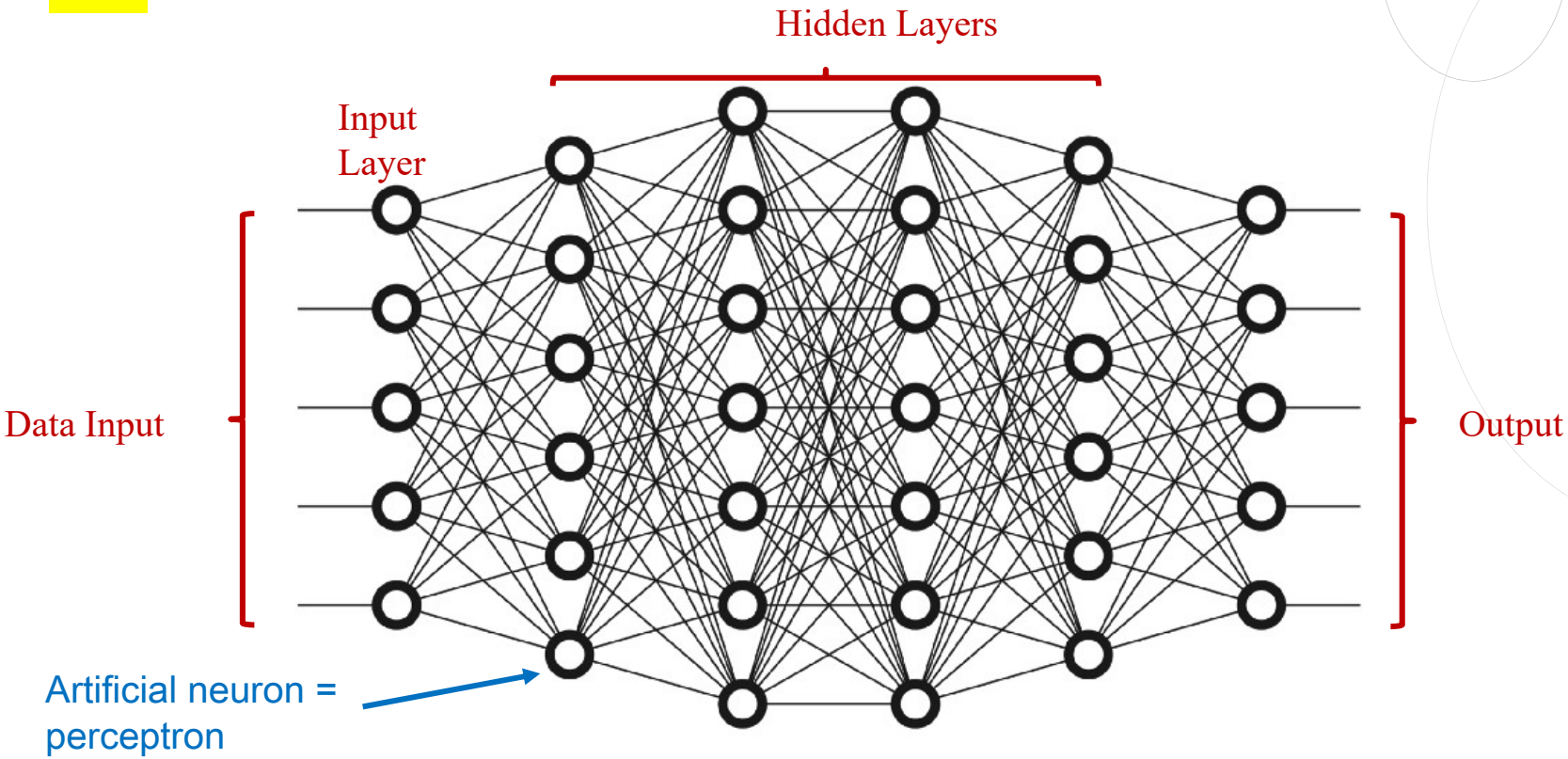




Food Safety Monitor using Sensor Technologies

- Obtain a basic knowledge on food contamination sources and types
- Identify a typical problem/bacteria
- Design and build a fast, effective, and accurate food safety monitor (mechanical system, sensors, data analysis/processing, interface & integration, final testing)

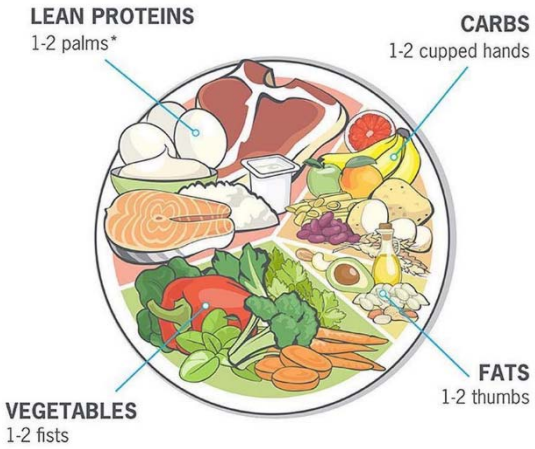
Artificial Neural Network for Feature Extraction



- **Using open source medical data, AI, and machine learning algorithm to exact the most important features**
- **Interpret these features**

Precision Nutrition using Artificial Intelligence

- Be able to use Matlab to conduct ANN analysis
- Study body sensing system (enzyme or hormone)
- Select one area to focus on
- Use ANN to predict the need for certain nutrition with a right cooking means, amount and timing



Potential Projects for Graduate Students

Design, Development, and Control for Human-Robot Interaction, Medical and Assistive Robotics

Mojtaba Sharifi
Assistant Professor
Department of Mechanical Engineering,
San Jose State University, CA, USA

April 28, 2023

Human-Robot Interaction (HRI) & Collaborative Robotics

ABB Collaborative Robots (video link):

YuMi, Collaborating on the assembly of socket at ABB Elektro-Praga

daVinci Surgical Robot (video link):

Robot Performs Minimally Invasive Surgeries with Extraordinary Precision

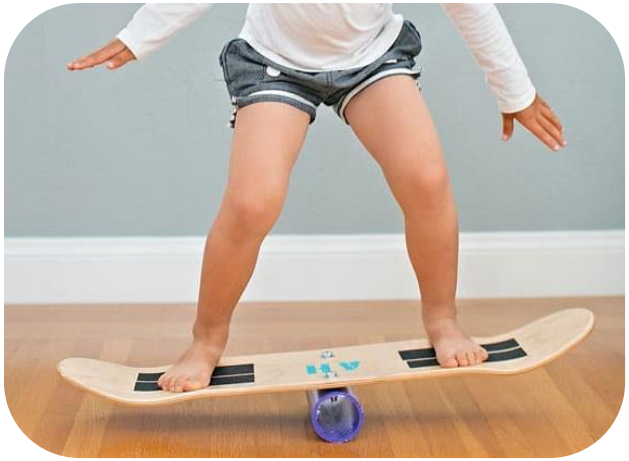
Harmony Upper-Limb Exoskeleton (video link):

Harmony, the robotic exoskeleton, can assist individuals who have had strokes or spinal injuries.

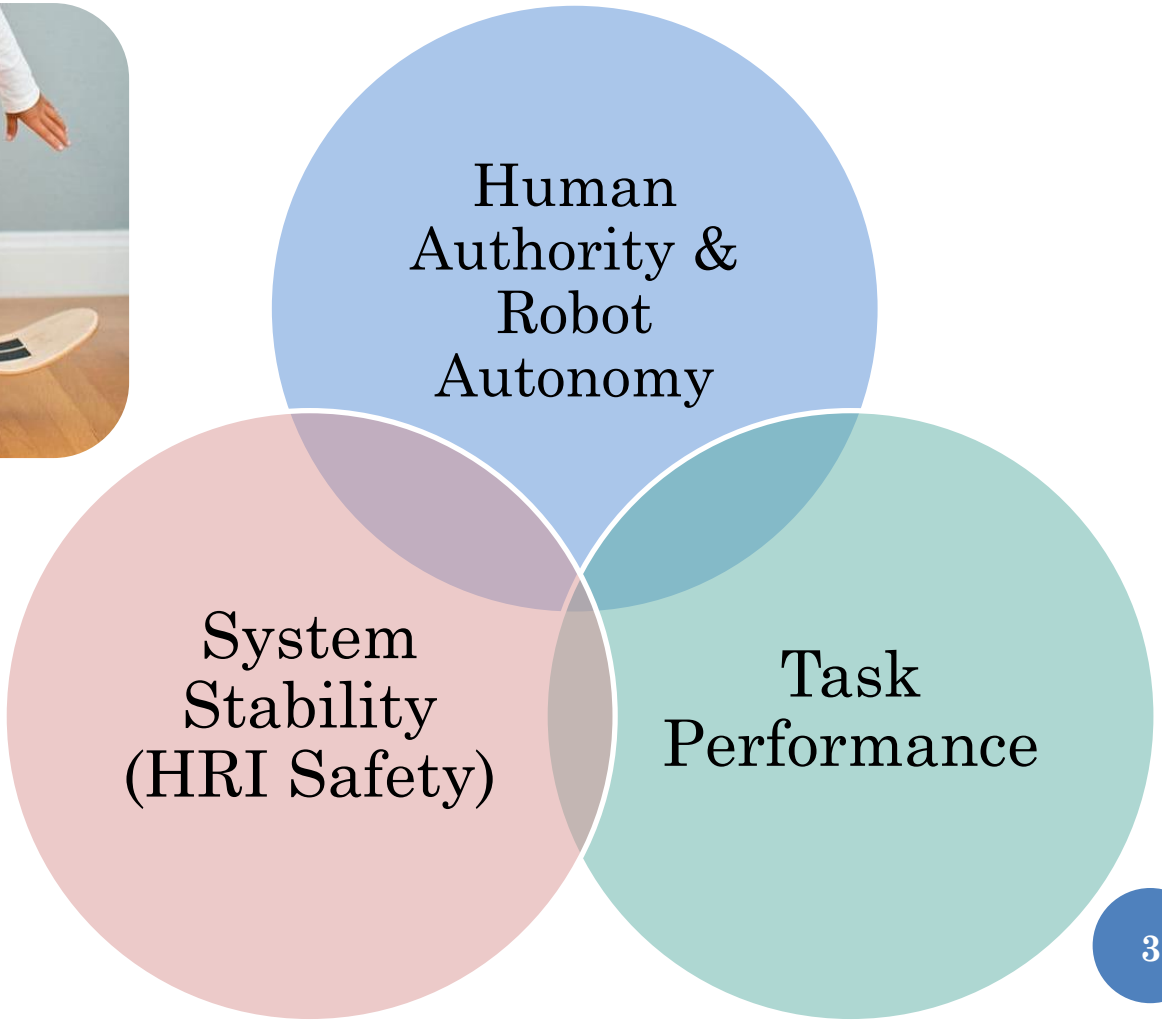
ReWalk Lower-Limb Exoskeleton (video link):

The ReWalk is a wearable exoskeleton that combines robotics with human assistance to make walking possible for individuals with spinal cord injuries.

Research Goal:
Balancing HRI Concerns

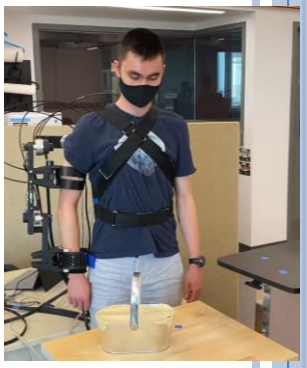


- **Design**
- **Control**
- **Learning**



Research Projects
Control, Robotics and HRI

- **Control** and **autonomy** of **robotic systems** for **HRI**
  - **Medical**, **collaborative** and **tele-operation** robotic systems
  - **High-level** & **low-level control strategies**
  - **Machine Learning (ML)** and **Artificial Intelligence (AI)**



- **Development** of **soft** and **wearable robotic systems**
  - **Design**, **prototyping** and **fabrication**
  - **Soft** robotic systems for **inherently safe HRI**
  - **Assistive exoskeletons** and **medical robots**: rehabilitation and surgery

- **Employing FES** and **EMG** with **musculoskeletal modeling**
  - **Optimal control** of **wearable**, **assistive** and **collaborative devices**
  - **Human behavior**, **intention identification** and **shared control** in **HRI**

- **Integrating auditory** and **visual data** via **speech** and **image processing**
  - **Combine physical HRI** and **social HRI:** faster and safer collaboration

Research Projects
Mechatronics, Robotics and HRI

- Topic 1: **Mechatronics development** and **control** of **exoskeletons**
  - **Design**, **prototyping**, **fabrication,** and **mechatronics**
  - **Light** robotic systems for **inherently safe HRI**

- Proposal 1: **Mechatronics and control of exoskeletons with medical and industrial applications**
  - **Applications:** assistance, rehabilitation, surgery, collaboration, weight compensation
  - **End-users:** workers (manufacturing, construction, weight handling industries), elderly people, individuals with disabilities
  - **Team:** 3-5 graduate students, 10-15 undergraduate students and co-ops, 1-2 technicians





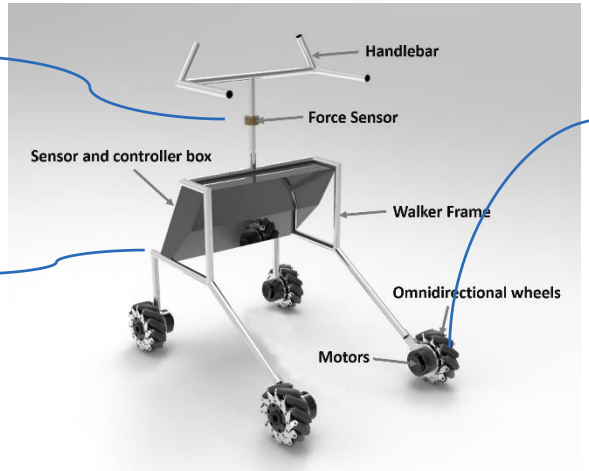
Research Projects
Mechatronics, Robotics and HRI

- Topic 2: **Design modification** and **control** of an **Intelligent Assistive Walker**
  - **CAD design** of the **walker structure**
  - **Mechatronics: motors, wheels, battery, sensors, and boards**
  - **Implementing control strategies** by **programming** the mobile robot

- Proposal 2: **Modification and control of a wheeled mobile robot for personalized mobility assistance and support during walking**
  - **Applications:** intelligent postural support using an omnidirectional mobile platform
  - **End-users:** elderly people and individuals with weaknesses
  - **Team:** 3-5 graduate students, 10-15 undergraduate students and co-ops

Force Sensor

Laser Sensor

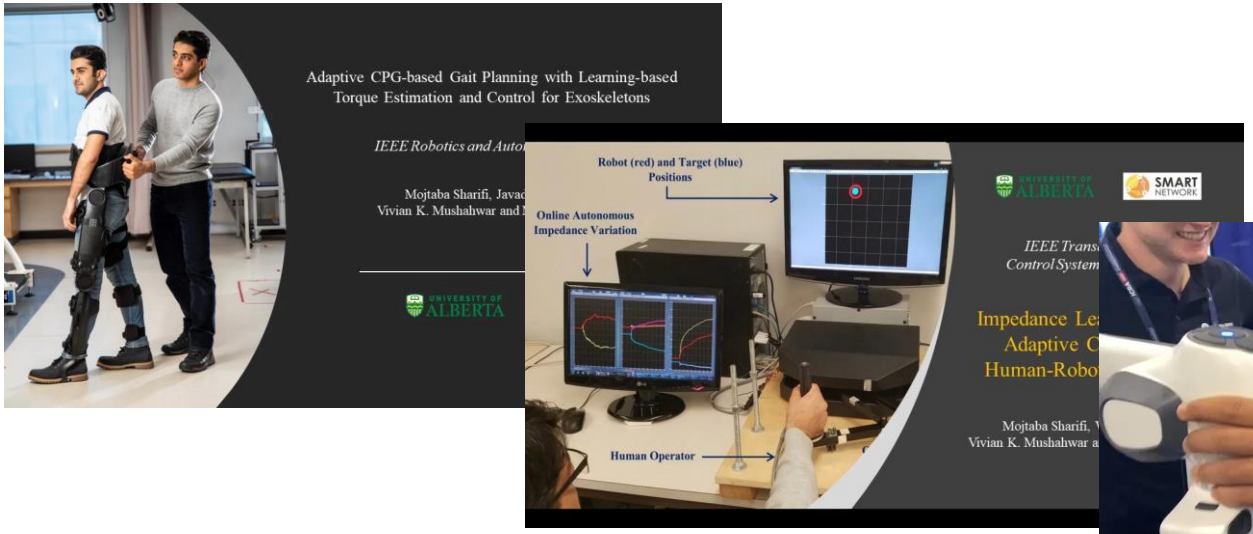


DC Motor & Omnidirectional Wheel

Research Projects
Mechatronics, Robotics and HRI

- Topic 3: **Control** and **autonomy** of **robotic systems** for **HRI**
  - **Medical**, **assistive** and **tele-operation** robotic systems
  - **High-level** & **low-level control strategies**
  - **Machine Learning (ML)** and **Artificial Intelligence (AI)**

- Proposal 3: **Intelligent robotic systems for safe human-robot interaction in collaborative and tele-operation tasks**
  - **Equipment:** pHRI systems and exoskeletons
  - **Team:** 4-6 graduate students and 7-10 undergraduate students and co-ops



Available now at SJSU for human-robot interaction:
Physical Therapy

Thank you!

Mojtaba Sharifi

Email: mojtaba.sharifi@sjsu.edu, Phone: +1-408-898-8254

Website: sites.google.com/ualberta.ca/mojtabasharifi

Google Scholar: scholar.google.com/citations?user=QXdM3CMAAAAJ&hl=en

ResearchGate: researchgate.net/profile/Mojtaba_Sharifi3

LinkedIn: linkedin.com/in/mojtaba-sharifi-9a0b66182

Available Projects for Fall 2023

Dr. Vimal Viswanathan
Associate Professor & Chair
Mechanical Engineering

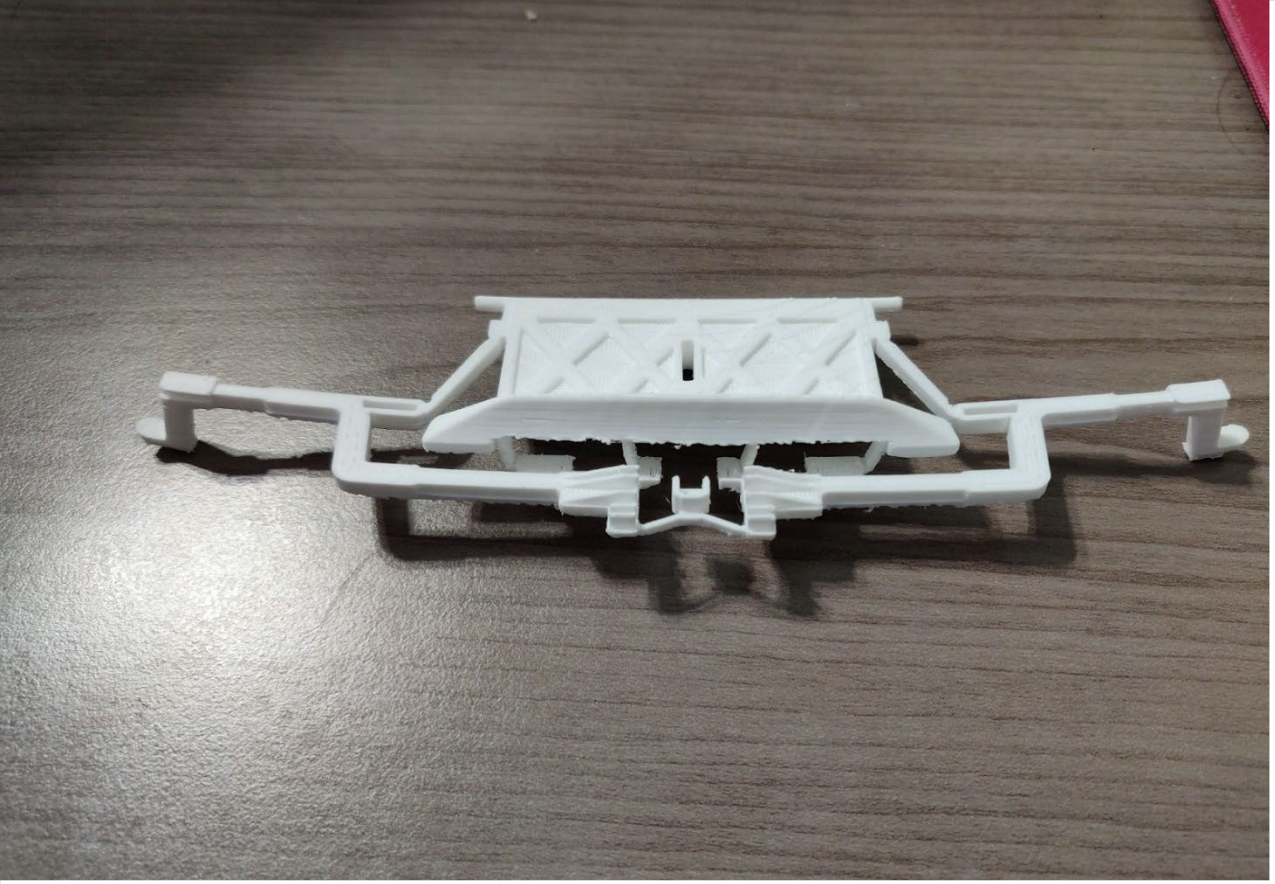
Areas of Research

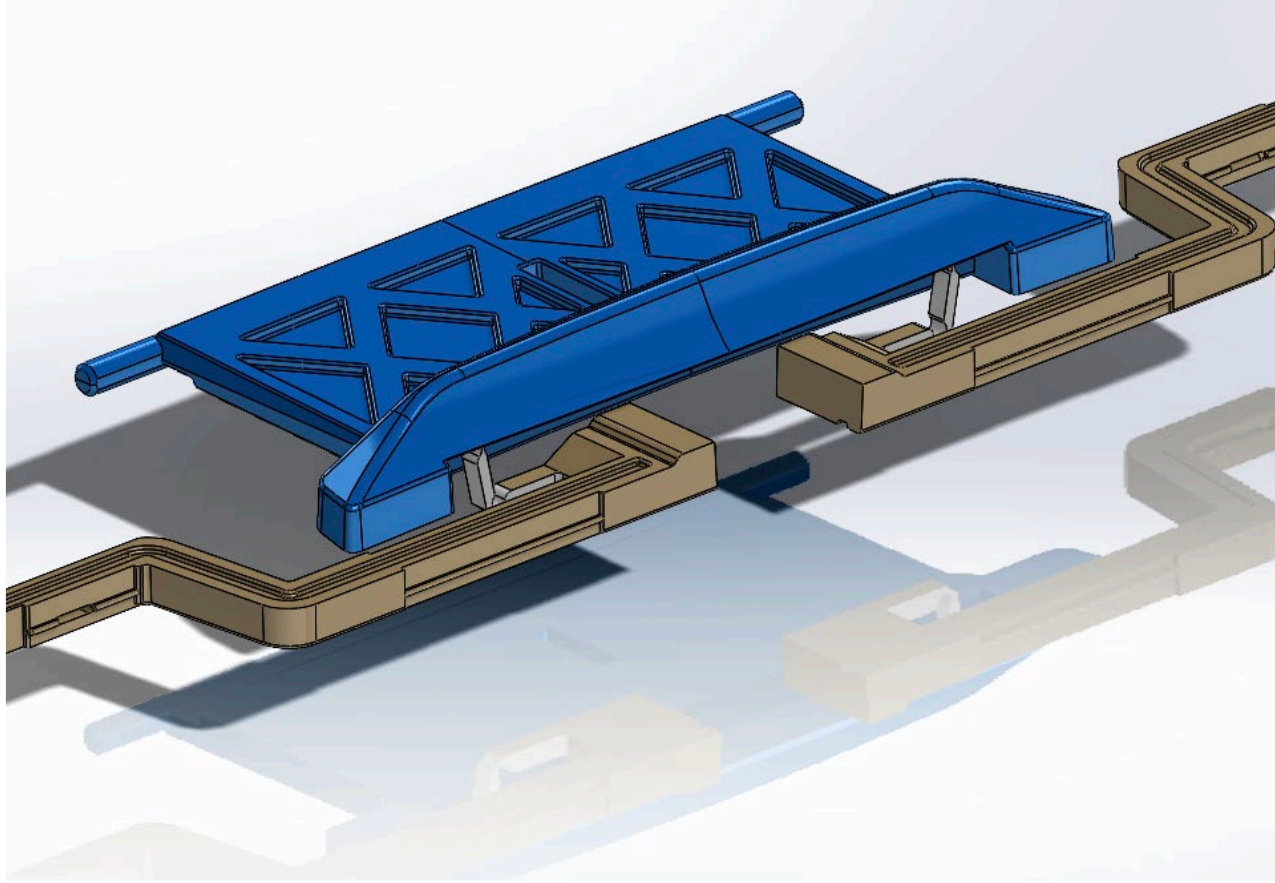
Primary Research Interests

Design theory and methodology
Design automation
AI/Machine learning in design
Product design
Engineering Education

Recent projects

Design automation (concluded - in publication)
AI/ML in design (ongoing project)
Design of rehabilitation devices (ongoing project)
Improving the efficiency of 3D printing processes (recently published)
New products and systems for green energy harvesting (recently published)
New products and systems for improving safety (ongoing projects)
The Spartan Hyperloop (multiple ongoing projects)



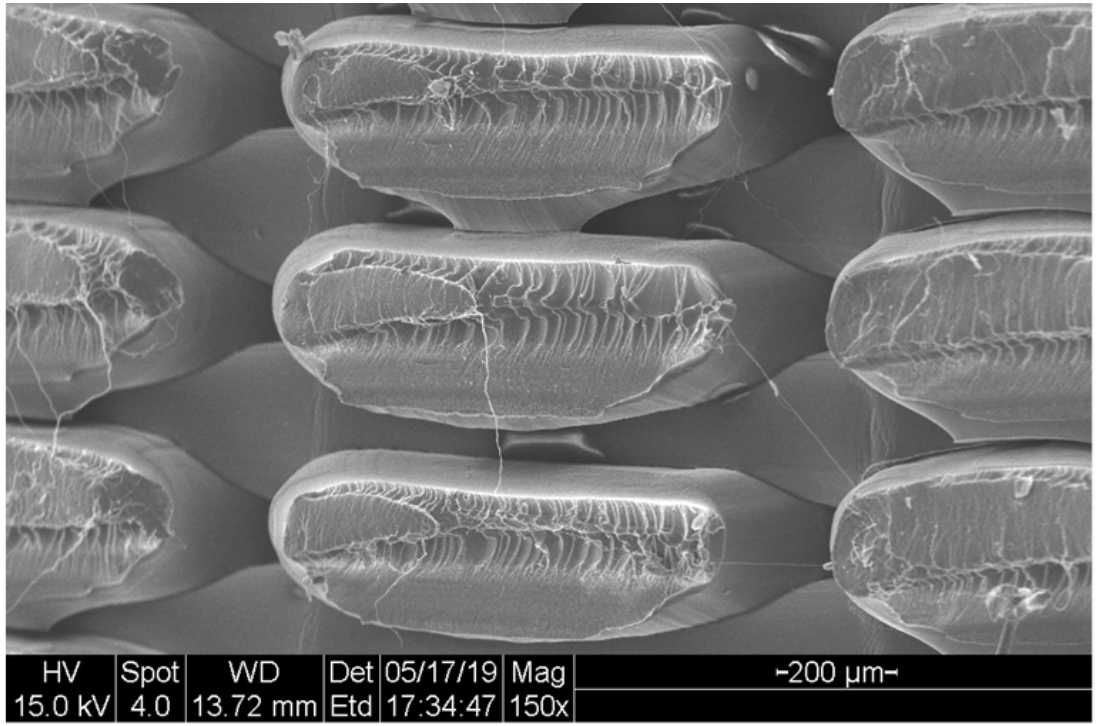


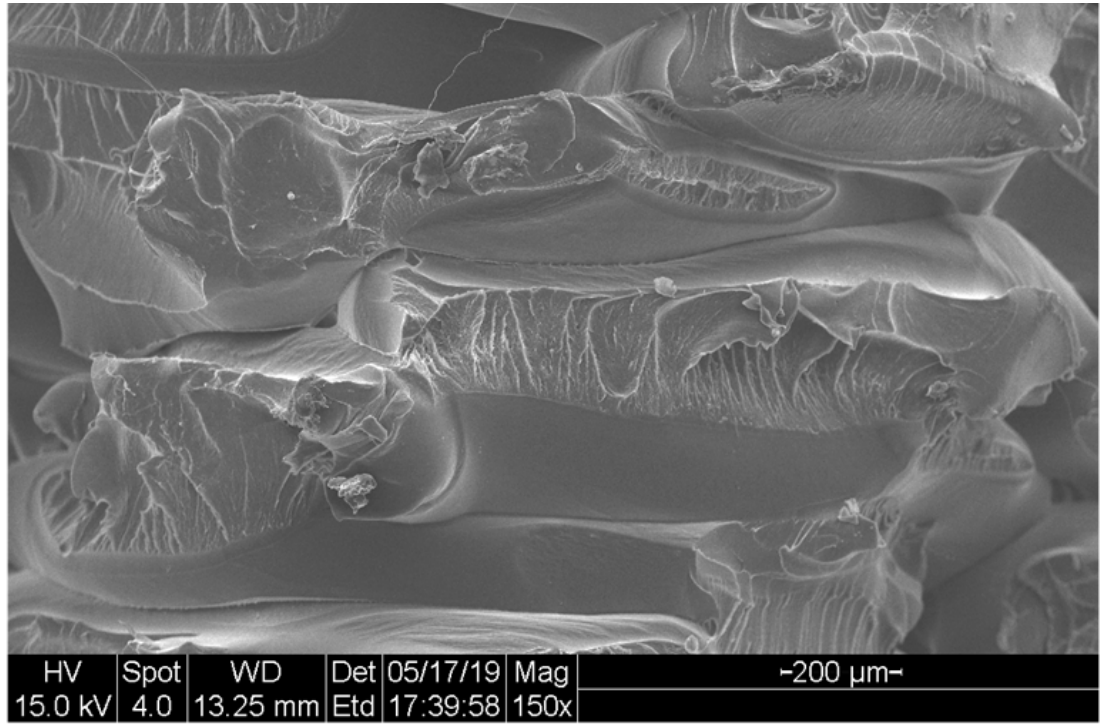
Design and fabrication of 3D printable function-sharing complaint mechanisms

Ideal candidate:
Mechanism design
3D printing

Revamping the Micrometrology Station

- Ideal candidate: mechatronics/controls, data acquisition
- Co-advisor: Dr. Ananda Mysore





Dei Rossi, J.; Keles, O.; Viswanathan, V. Fused Deposition Modeling with Induced Vibrations: A Study on the Mechanical Characteristics of Printed Parts. Appl. Sci. **2022**, 12, 9327. https://doi.org/10.3390/app12189327

Characterization of fatigue properties of 3D printed polymers

- Ideal candidate: 3D printing, mechanical testing

My contact information

- vimal.viswanathan@sjsu.edu

MSME Fall 23
Available Projects

Lin Jiang
Assistant Professor
Mechanical Engineering
lin.jiang@sjsu.edu

Areas of interests

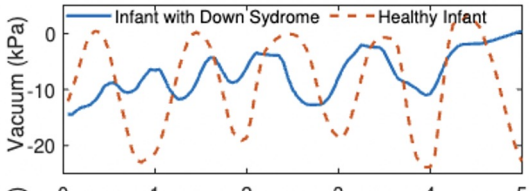
Human Biomechanics

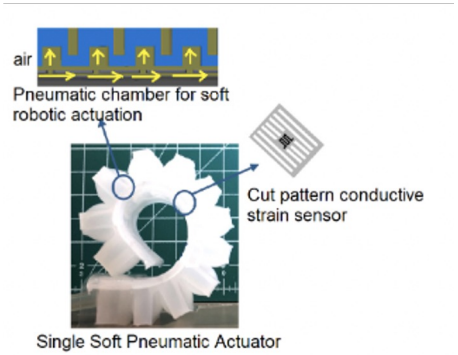
- Medical Device
- Neonatal ICU Care
- Maternal Health

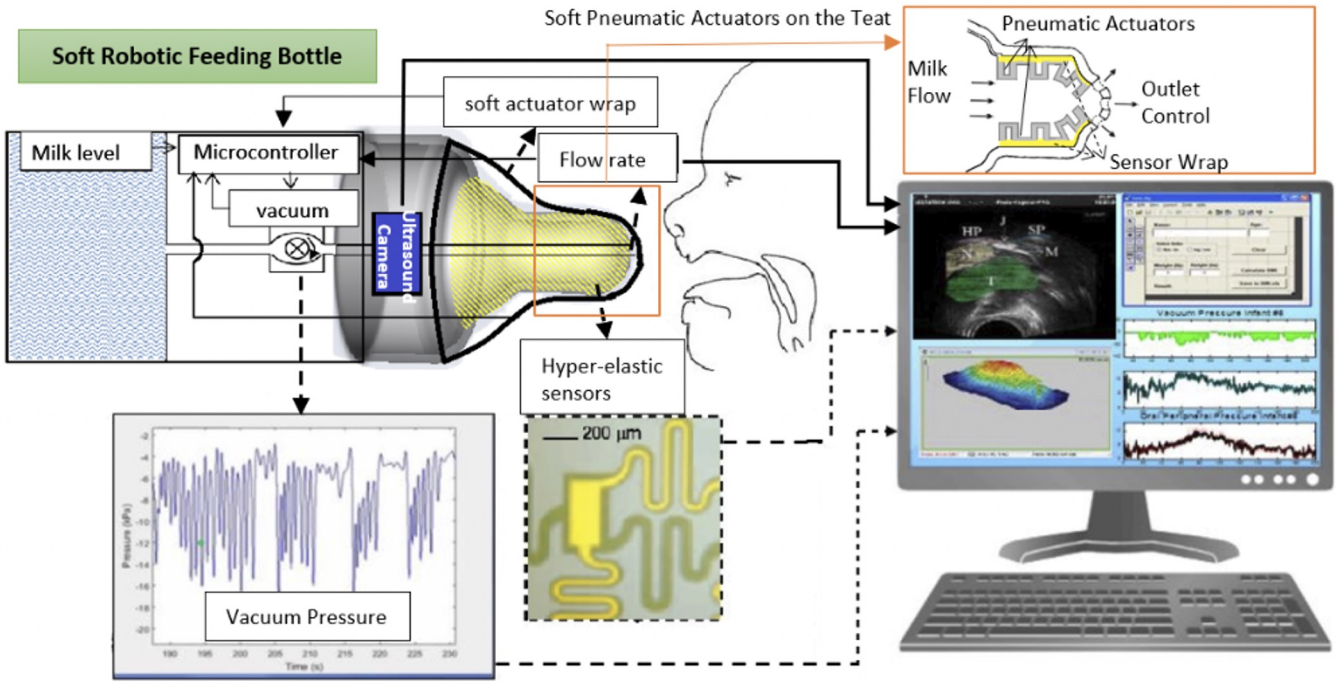
Robotics and Mechatronics

- Haptic feedback and Virtual reality in robot control
- Human in the loop robot control
- Teleoperated Robotic System
- Surgical robots

Robotic Milk Bottle for NICU Feeding



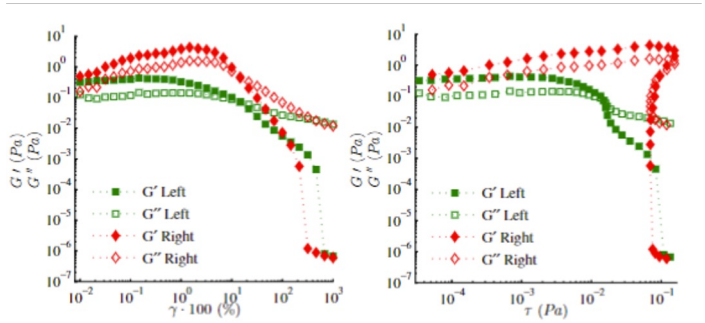




Human Milk Rheology study for Flow Dynamic Analysis

Nutrients	Nutrient Requirements for preterm infants< $1500g$ [20]	$20kcal/oz$ Untreated BM [21]	$24kcal/oz$ BM + HMF [21]	$30kcal/oz$ High protein BM + HMF [21]	$20kcal/oz$ Enfamil Premature with Iron®[2] [22]
Fluids (ml/kg)	-	180	150	120	148
Energy $(kcal/kg)$	120	120	120	120	-
Protein (g/kg)	4	1.8	3	4.1	3.0
Fat (g/kg)	2.4	3.5	3.5	3.5	5.1
Calcium (mg/kg)	100-200	50	214	218	165

1. BM: Breast Milk; HMF: Human Milk Fortifier.
2. Used with permission of Mead Johnson & Company, Evansville, IN 47721. From Enfamil Family Products Handbook, Mead Johnson Nutritionals, Mead Johnson & Company. [23]



(a) Donor (participant #6) human milk shear strain **(b)** Donor (participant #6) human milk shear stress

Figure 2: Viscoelastic behavior of human milk. The crossover points on the strain graph show how much milk needs to deform to ensure homogeneous flow while the stress graphs show the required pressures. [27]

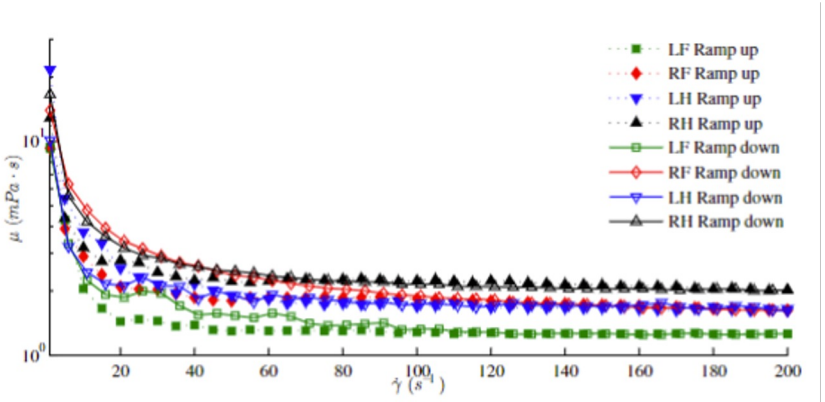
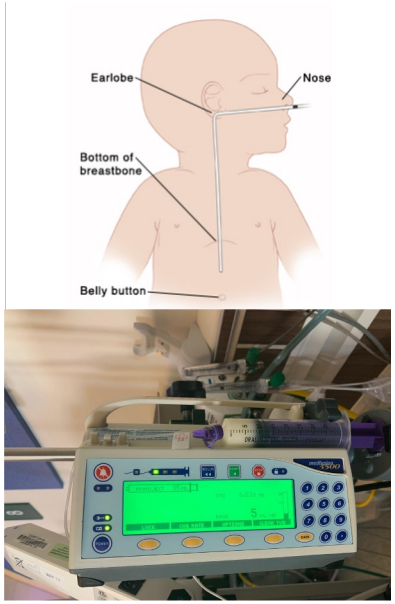
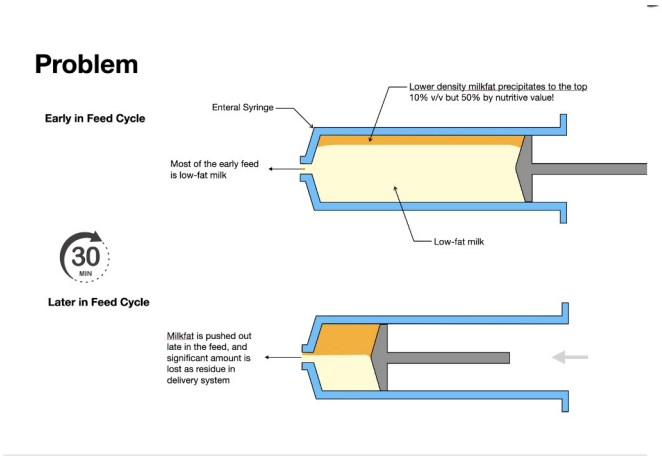


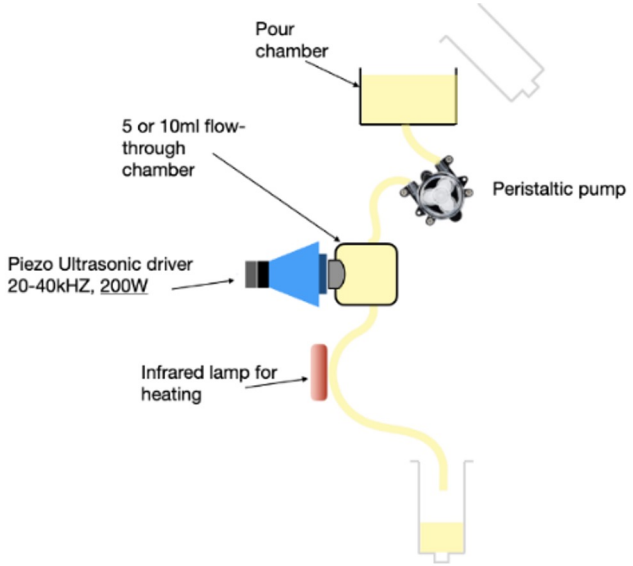
Figure 1: Evidence of time dependence for human milk flow properties. The loop test demonstrates time dependence for human milk for both pre-(foremilk: F) and post-expression (hindmilk: H). The viscosity of milk from the right breast (R) ended higher while milk from the left breast (L) ended lower. [19]

Determine the variation in flow behavior of untreated human milk and infant formula with and without different degrees of thickening

Human milk homogenizer for Pre-term Infants







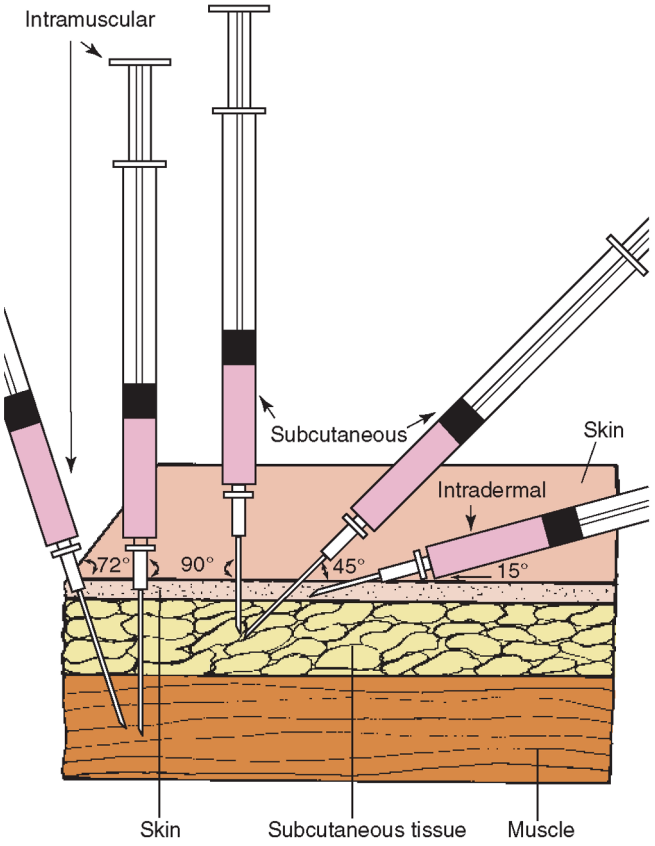
We intend to build an enteral syringe (UNIFEED) system that, when mounted on a horizontal infusion pump, delivers more consistent nutrition to the neonate throughout the feed cycle by

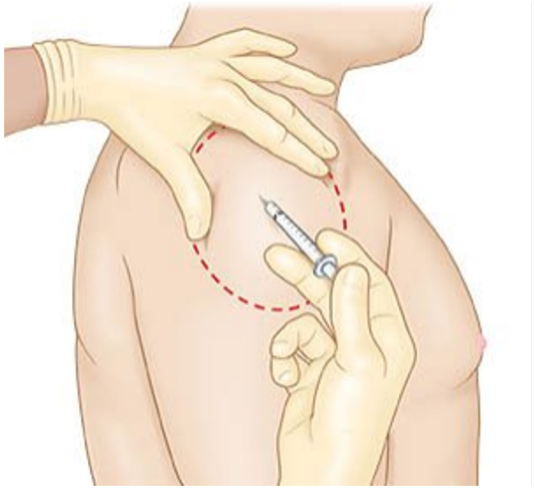
(a) creating a path for milk from the fat accumulation zone on top to flow to the syringe outlet;

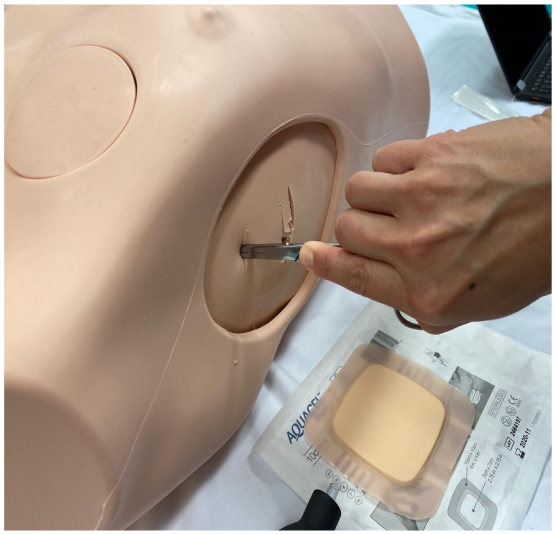
(b) homogenizing the milk with piezo ultrasonic driver;

(c) creating a lipophobic (fat-repelling) surface on the face of the piston, thereby preventing fat accumulation towards the end of the feeding cycle.

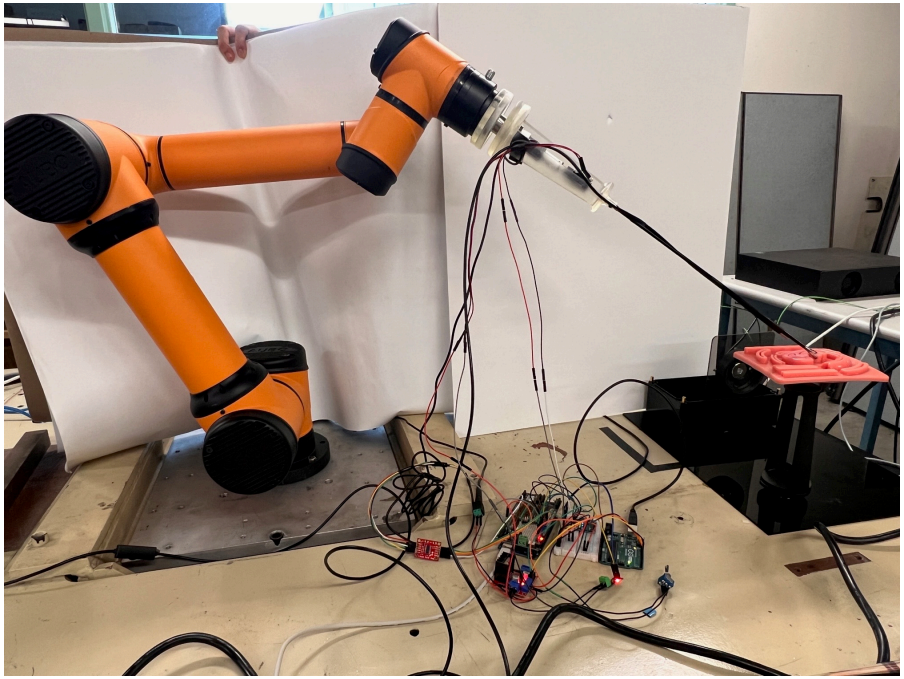
Telerobotic Intramuscular insertion operation

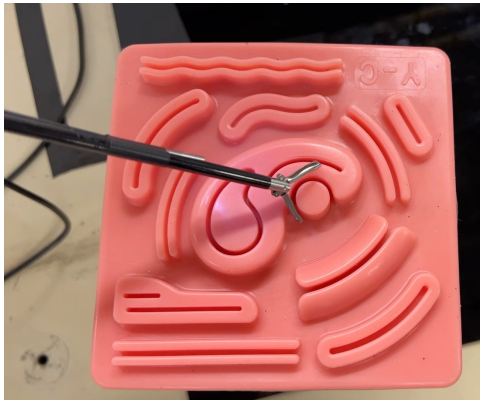


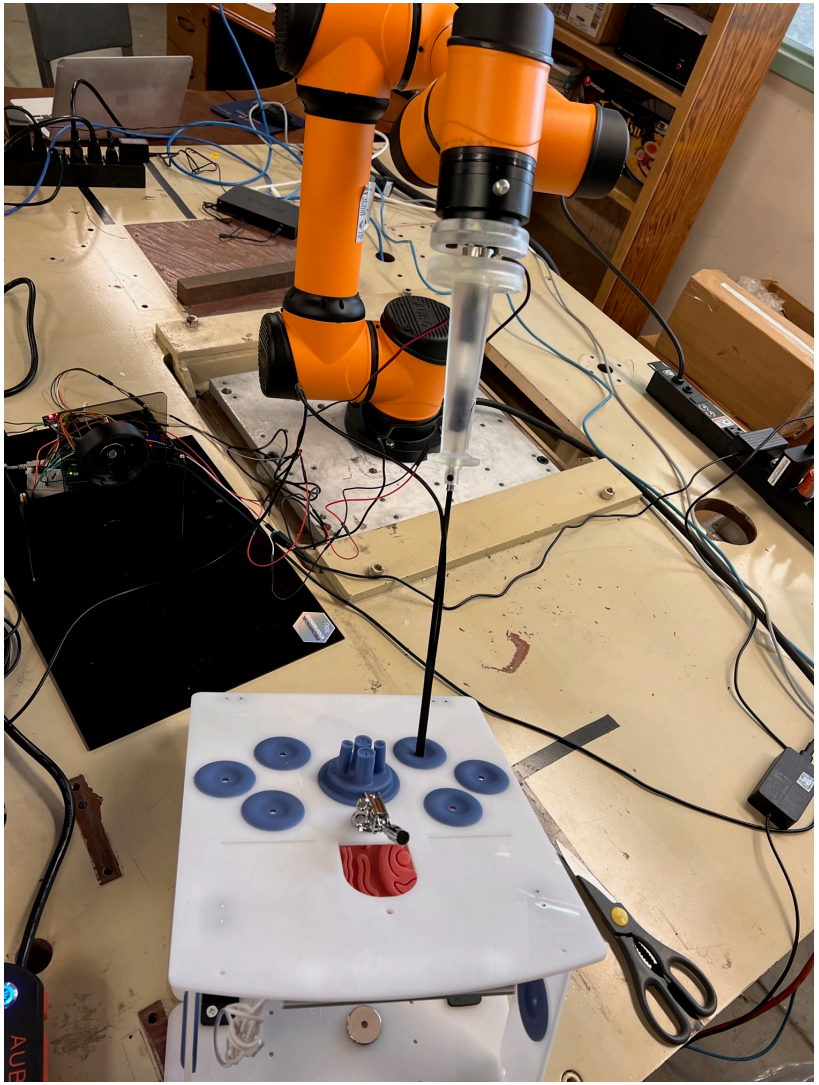




Forced-based Impedance Robot Control for Tele-Surgery

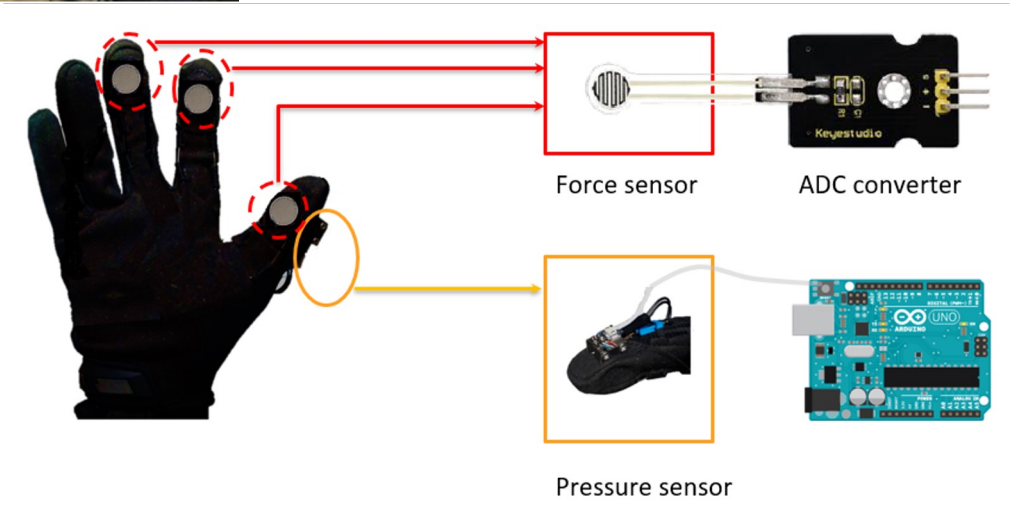


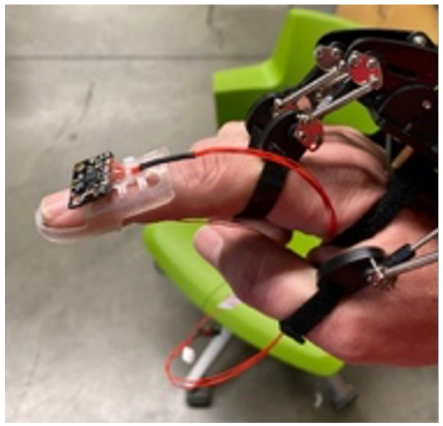




Wearable Haptics Glove

1. Design light-weighted, easy assemble and smart wearable glove.
2. Intelligent control and customize solution with tactile sensing and feedback;
3. Provide **two-way haptic information**;
4. Applications to VR and Teleoperated Robot control





Human in the loop Autonomous Driving

Sponsored by
Honda Foundation

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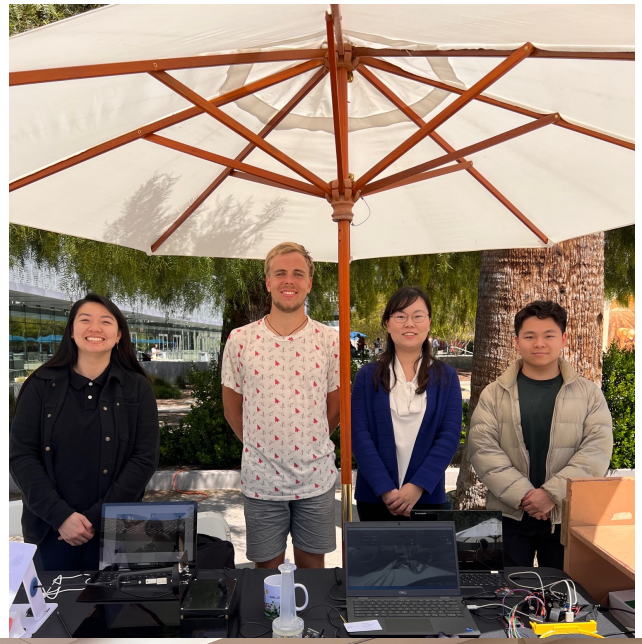

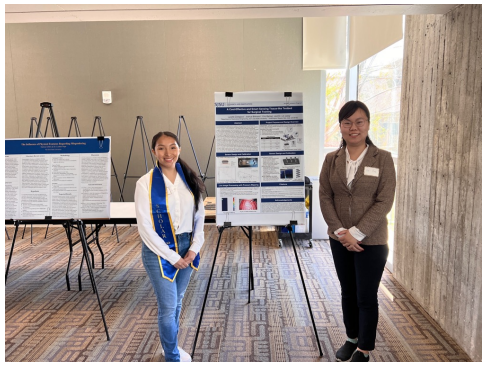

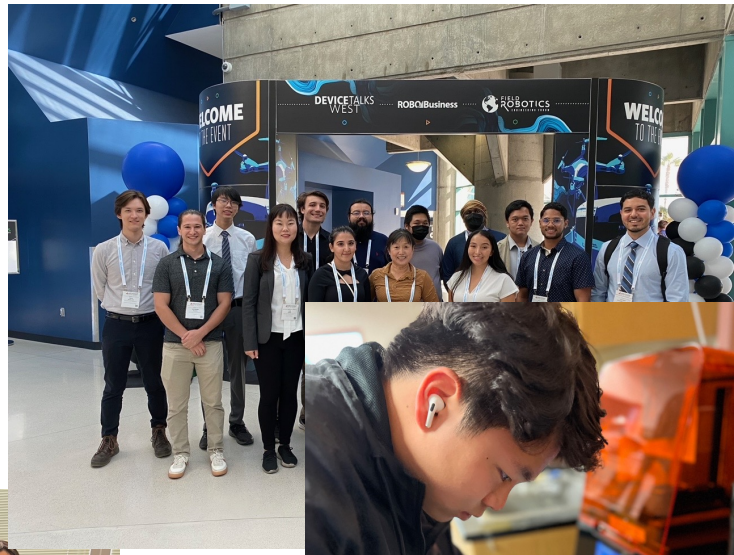

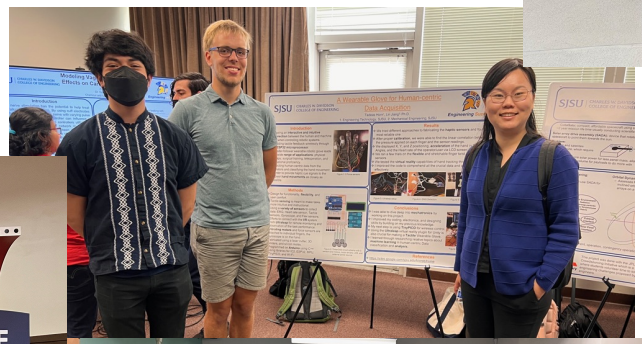

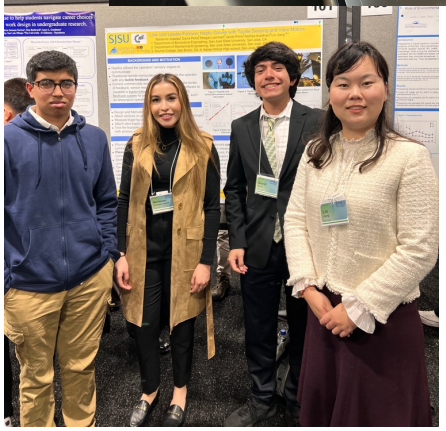

Thank you!

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Dr. Bashash's Project Topics

1. Development of a low-voltage, high current battery cycler for EV battery testing
   - Requires strong background in mechatronics and basic electronics

2. Control of flexible non-minimum-phase servo positioning systems (Comparison of PID, LQG, and frequency domain controllers)
   - Requires background in digital control systems (ME 281 and/or ME 282)

For more information, please contact saeid.bashash@sjsu.edu