

# PORTFOLIO



## ATHARVA MESTRY

**Mechanical & Robotics  
engineer who loves  
turning ideas into real  
machines.**



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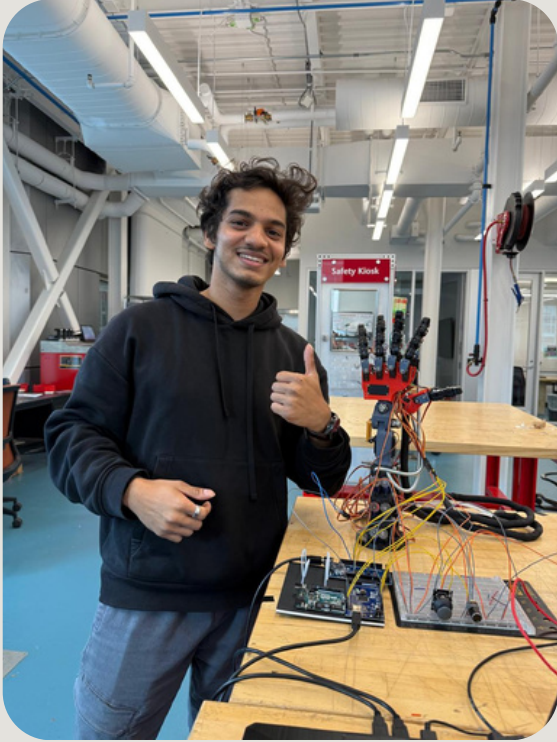


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The New York Metropolitan Area

## Humanoid Robot Hand



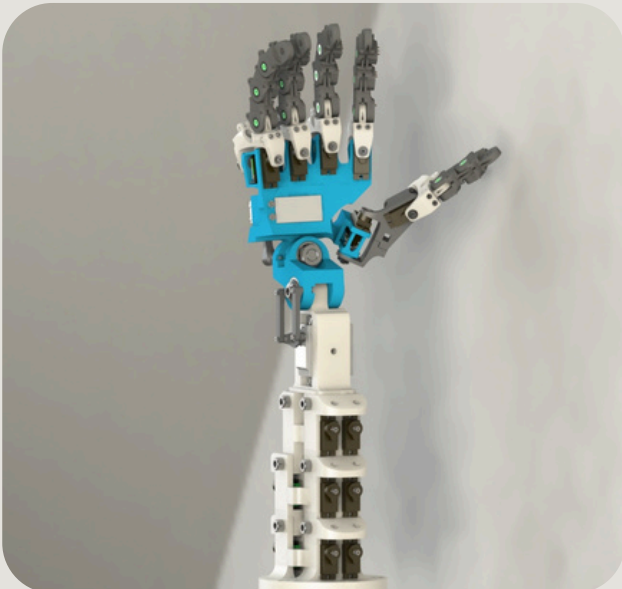
During my Master's, I worked on a hands-on project to design and build a robotic hand mimicking the dexterity of the human hand which heavily tied my interest in mechanical design and Robotics control systems together.

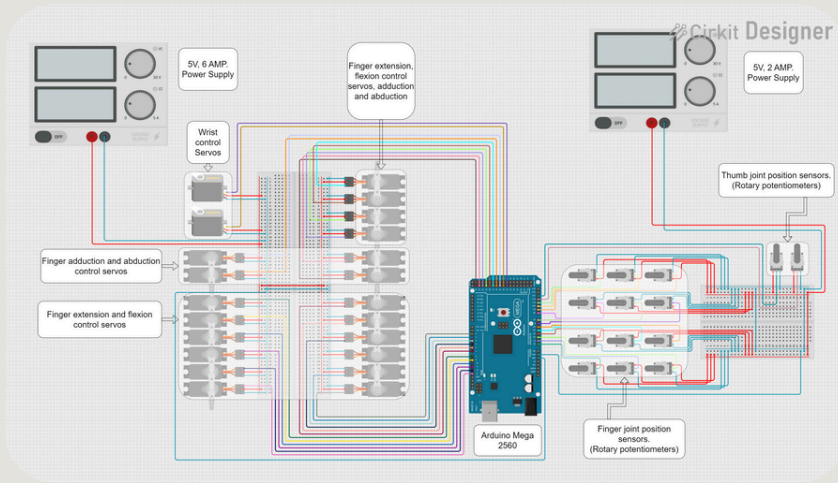
The idea was to view how we could integrate mechanical components with control logic in a natural and functional manner, especially for use in the real world situations like prosthetics or humanoid robots. I built and designed everything from scratch: starting with 3D modeling, then fabrication, design iteration, assembly, and testing.

The current hand version has 22 DOF, which is quite near to a human hand's 27 DOF. I used a combination of direct servo drive and servo driven tendon system for more natural motion and PID control logic for precise joint control. I also used micro potentiometers for position feedback to increase precision.

Right now, I'm working on adding a computer vision system to give the hand more precise control, so it can react to its environment and be useful in more advanced scenarios.

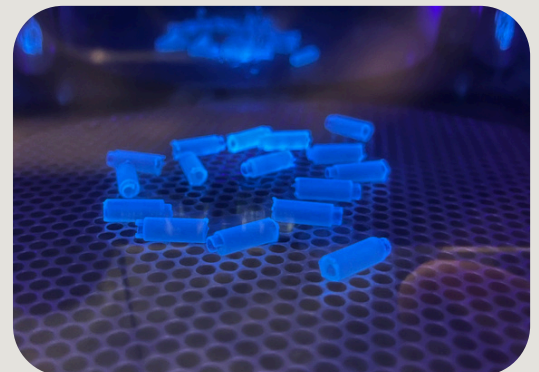
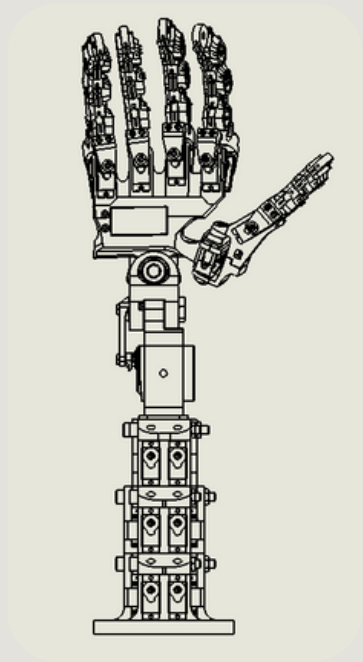
Overall, it's been a really rewarding project that pushed me to connect mechanical engineering principles with embedded control and system integration in a meaningful way.



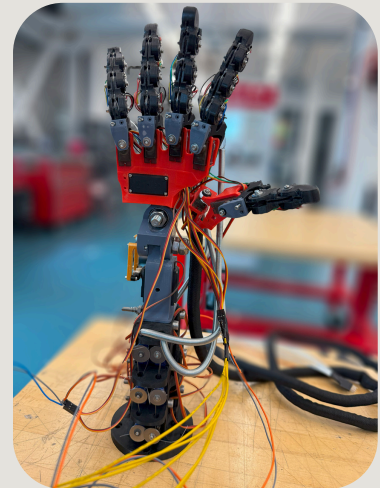
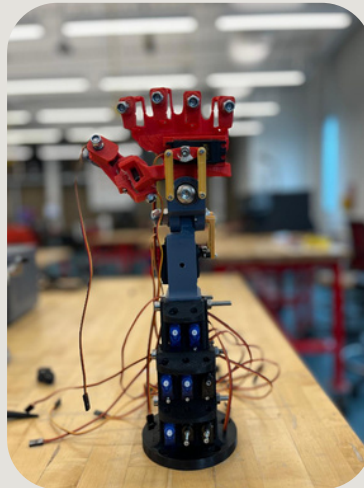
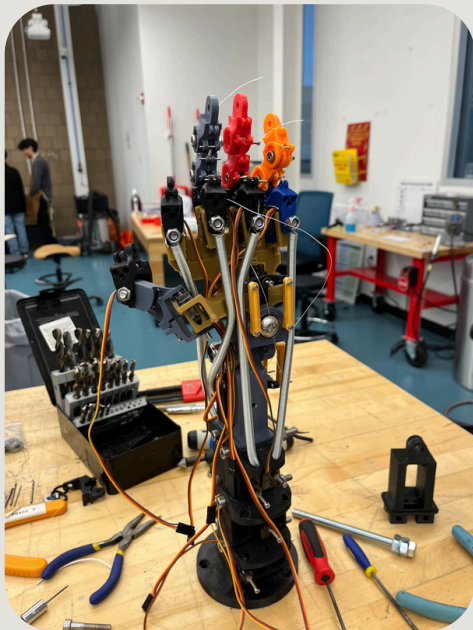
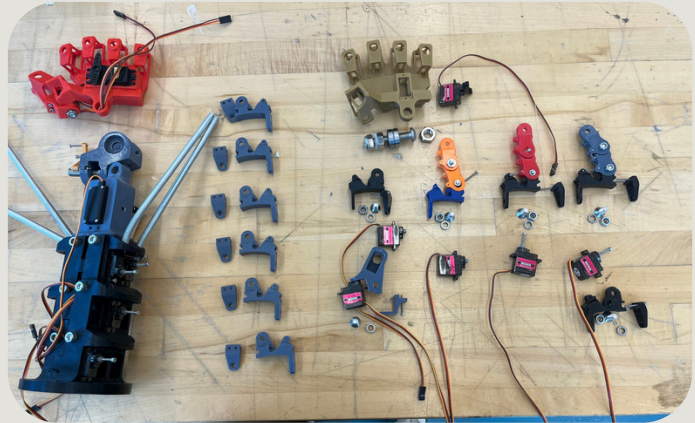


Control system architecture

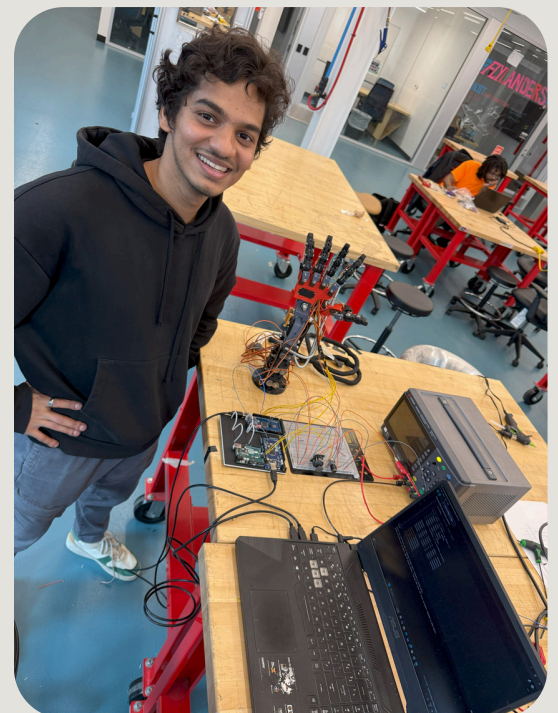
CAD modeling, assembly, motion planning using solidworks and rapid prototyping using SLA and 3D printing



## Part assembly and design iteration



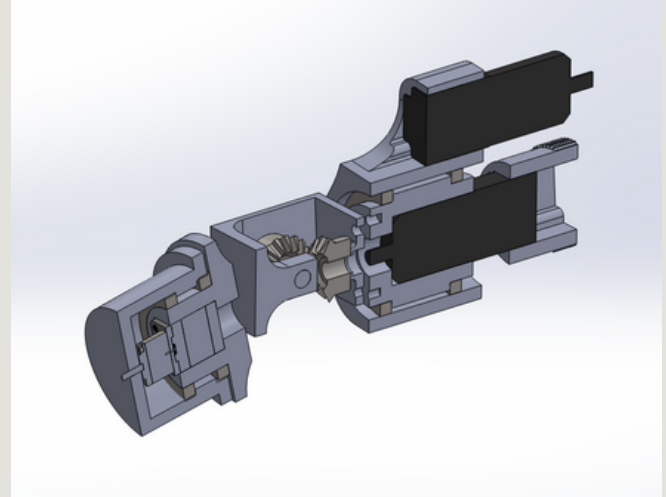
## Programming, troubleshooting and testing



I was also working on developing shoulder joint and elbow joint to complete the humanoid robot arm

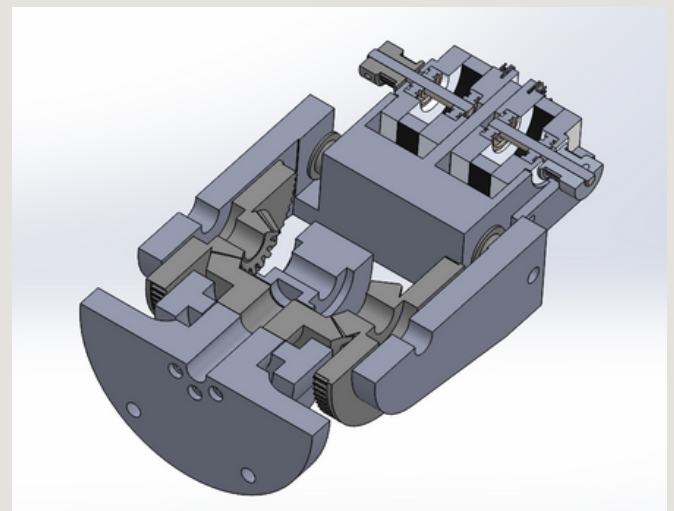
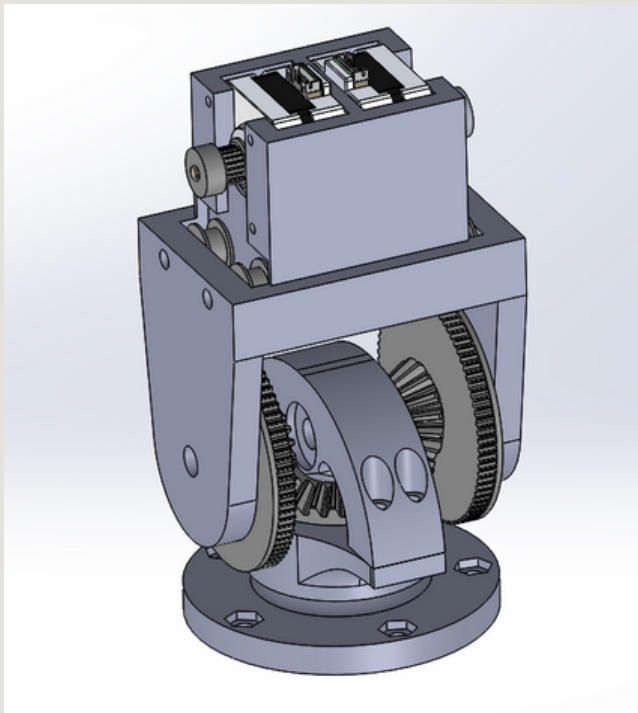
**Shoulder joint**

**Shoulder joint section view**

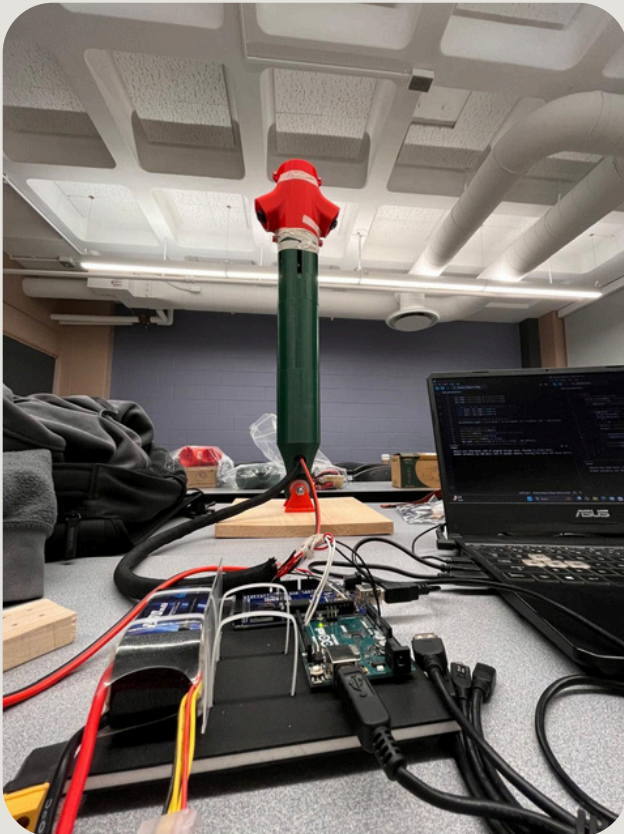


**Elbow joint**

**Elbow joint section view**



## PID controlled Rocket Stabilization



As the final project for my robotics course, I aimed to do something significant that involved real-time sensing, control systems, and hardware integration. Inspired by SpaceX Starship booster landings, I led a team of four in designing and creating a rocket body stabilization system with a 3D-printed prototype.

We sought to create a system that would detect when the rocket is moving away from vertical alignment and would automatically correct by modifying thrust with small electric ducted fans — basically mimicking how real full-scale rockets stay balanced in flight or descent.

I oversaw the entire system design as team lead and Developed an differential PID algorithm.

We added an accelerometer to measure tilt angles in real time.

The data was passed to an Arduino Mega, which passed it to MATLAB via serial communication.

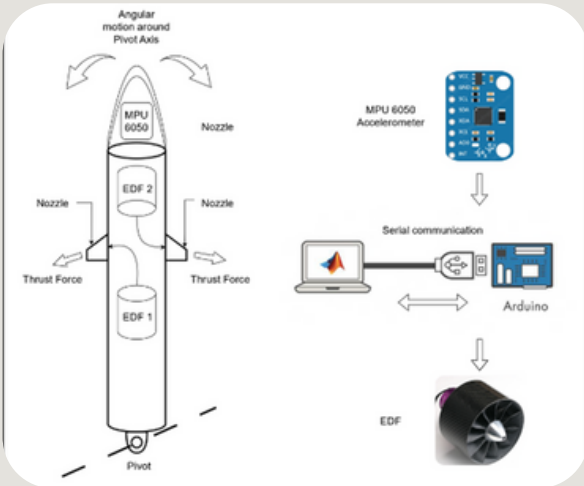
I encoded the control algorithm in MATLAB to calculate the necessary thrust corrections, then passed those on to an Arduino UNO.

The Arduino converted the values into PWM signals to control ESCs, which then controlled the EDF (Electric Ducted Fan) output to corresponding values.

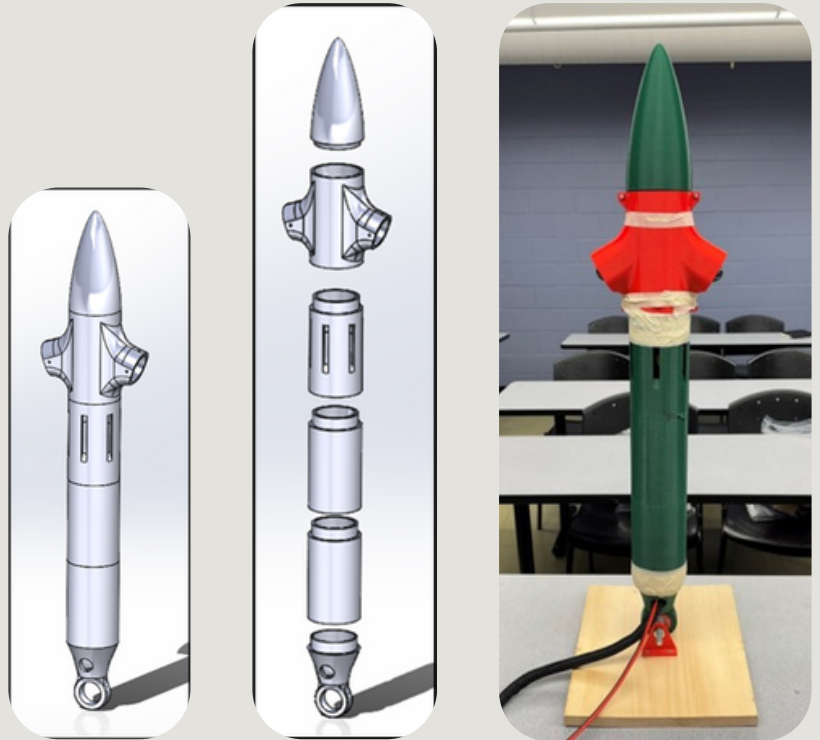
This cycle ran continuously, allowing the system to respond to real-time disturbances and dynamically correct the rocket's position.

We were successfully able to test a fully operational closed-loop stabilization system that could respond to tilt and remain in vertical balance. It was a great hands-on experience that tied everything we studied in class together — from embedded systems and sensors to control theory and teamwork. For me, it also further developed my interest in aerospace systems and real-time control of robots.

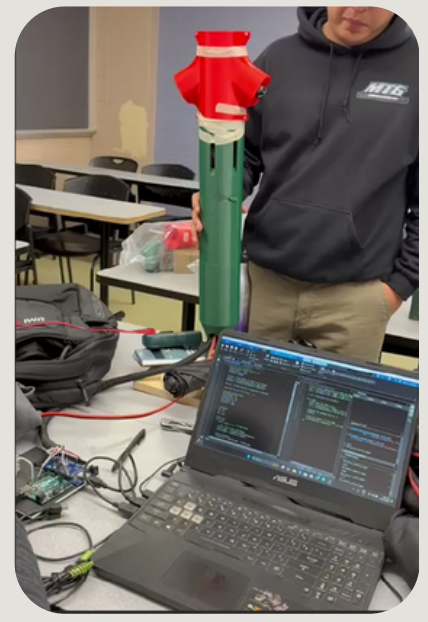
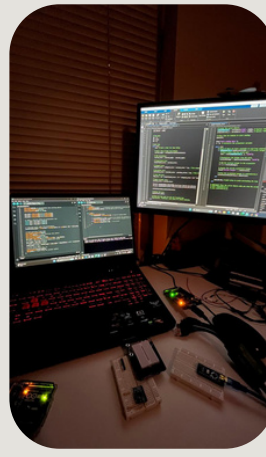
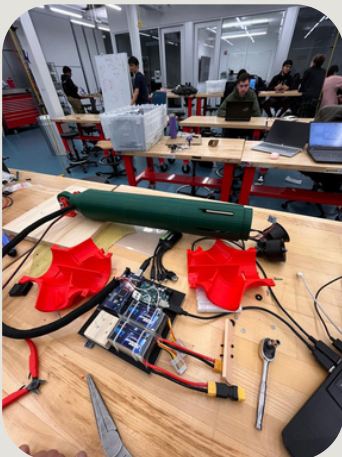
## Control system architecture



cad modeling, rapid  
prototyping using 3D  
printer, and assembly

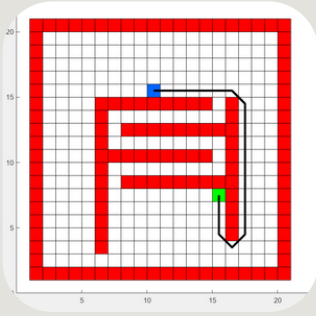


Electronics intergration,  
programming and testing

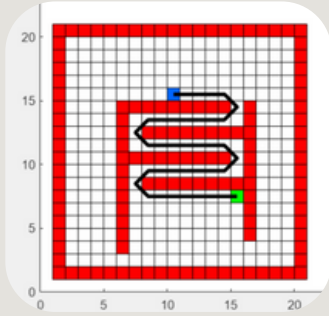


## Path Planning and Perception for Autonomous Navigation in Uncertain Environments

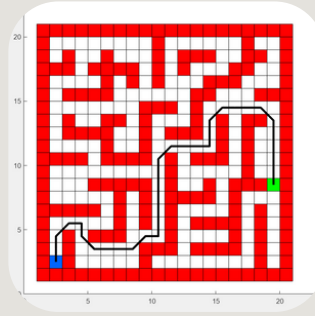
### Path planning



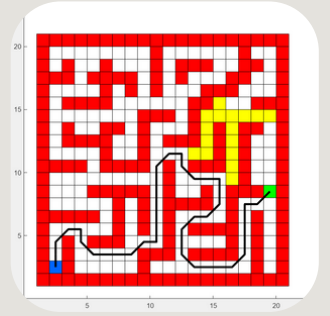
Using just A star search Algorithm



Using waterfall logic with A star search Algorithm



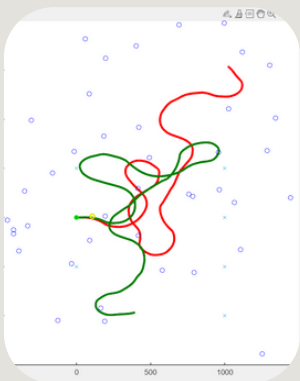
A star search algorithm



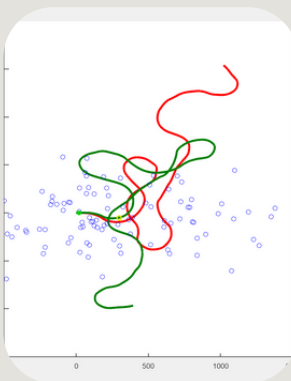
A star search algorithm with added cost obstructions

I utilized MATLAB to implement both A\* and Dijkstra's algorithms for pathfinding problem-solving in a number of different environment types. By adding heuristic-based reasoning with A\*, I was able to reduce redundant node expansions by some 30%, which actually made the route calculations notably faster and more efficient — a big advantage for real-time robot navigation.

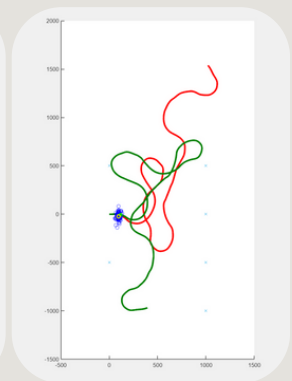
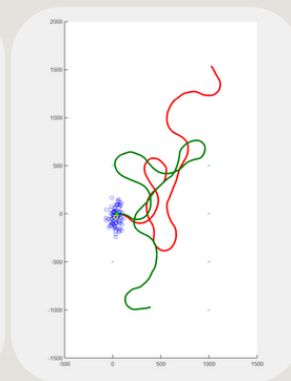
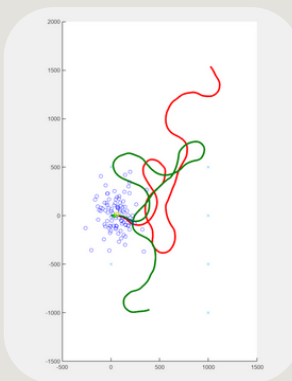
### perception using Particle Filter



initial state estimation



state estimation after few seconds for tuned keep ratio and partical counts.

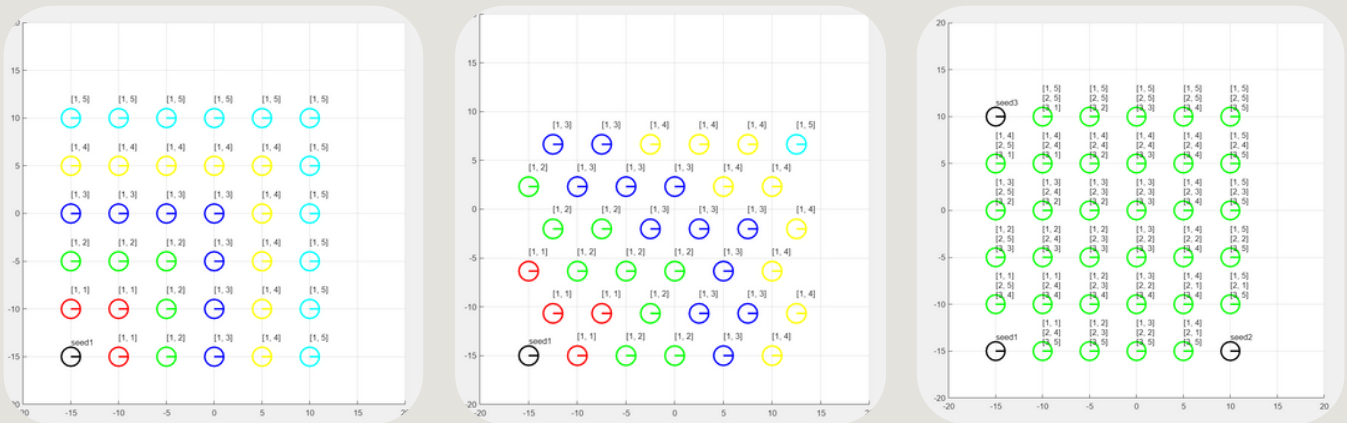


I created and tuned a particle filter algorithm in MATLAB to help guide a robot more precisely in estimating its position when it is moving. By adjusting the number of particles and keep ratios, I was able to tune the filter to give better accuracy while making it light enough to use effectively within real-time systems.

## Flocking and Adaptive Swarm Behavior

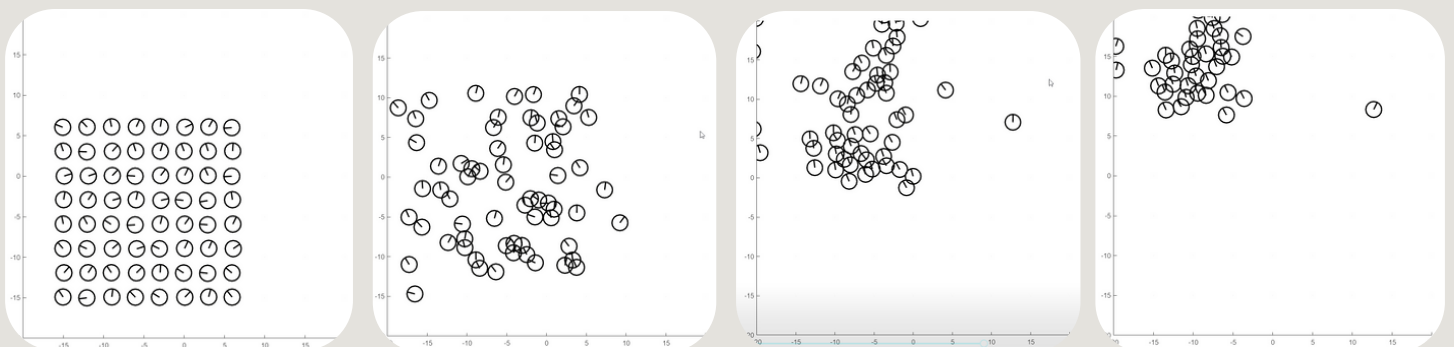
### Hop count propagation

I programmed a hop count propagation logic in MATLAB to accurately determine the relative position of each robot in a swarm. The logic allowed robots to exchange hop count information with their neighbors, helping build a simple distributed map of the swarm layout without using GPS.

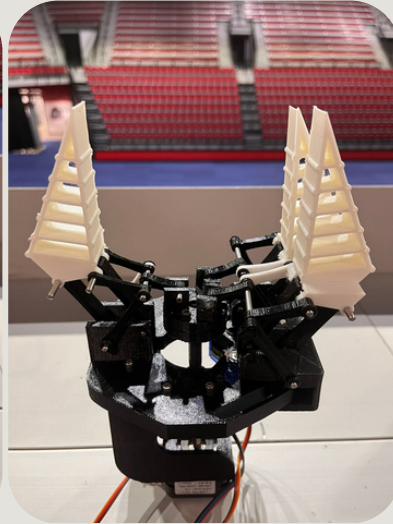
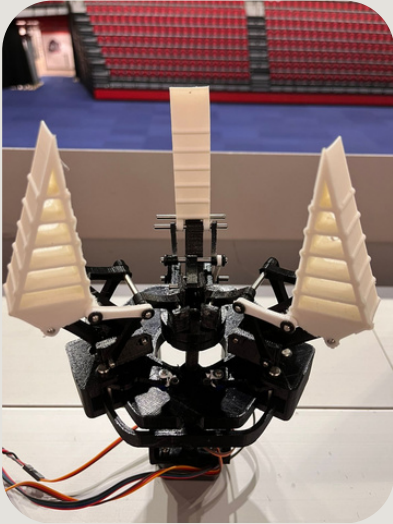


### Robot Flocking

I implemented a decentralized control logic for a robot swarm in MATLAB to simulate bird flocking behavior, by varying parameters of separation, cohesion, and alignment (directional control). The project was a modification of the classic flocking algorithm, which demonstrates how collective motion can be achieved by local interactions between individual agents. In MATLAB simulations, I demonstrated how the swarm could be translated in bulk without a centralized controller. This approach has potential uses in search and rescue, environmental monitoring, and distributed exploration, where sets of robots can sweep through vast, uncharted regions economically without the need for central control.



## MorphoGrip: Adaptive Robotic End Effector with Dynamic Configuration and Shape-Morphing Capability.

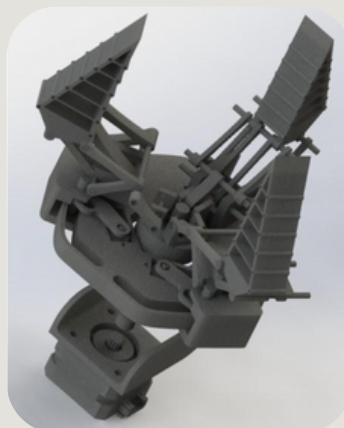
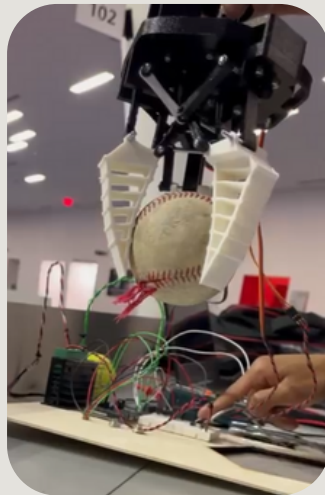


One of the big challenges in robotic manipulation is designing grippers that can handle objects of all shapes and sizes — without losing precision or grip strength. For one of my projects, I focused on building a versatile robotic end effector that could switch between two-finger and three-finger modes, making it more adaptable for use in unstructured or automated environments.

The goal was to design and prototype a gripper that could smoothly change configurations and reliably grasp a wide variety of objects. That meant figuring out the right mechanical design, choosing suitable materials, and building a control system that could operate everything smoothly and precisely.

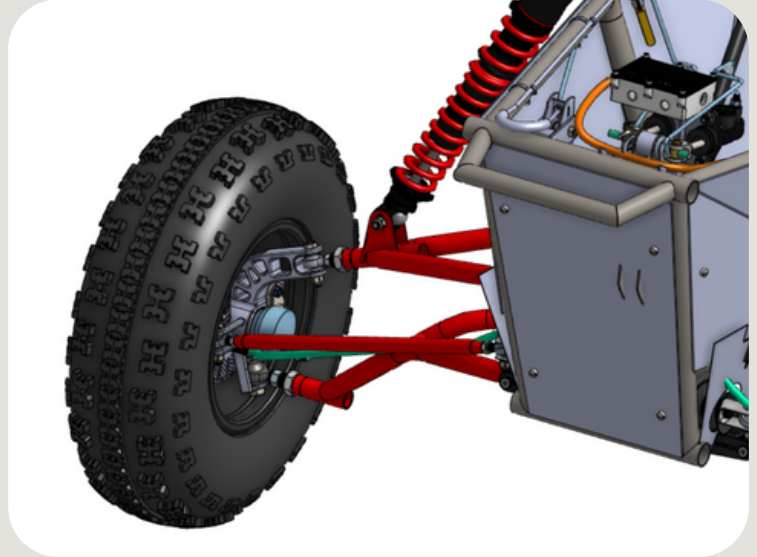
- I started by running a kinematic analysis of different mechanical setups to find the most efficient design for finger movement and smooth mode switching.
- Then I used Finite Element Analysis (FEA) to test different soft polymer materials, making sure the gripper would be flexible and durable enough for repeated use.
- The design was modeled in CAD and fabricated using 3D printing, which made it easy to test and iterate quickly.
- I built a microcontroller-based control system to remotely operate the gripper and fine-tune the grip.
- Finally, I tested the prototype on a variety of objects to see how well it adapted — and it performed reliably across the board.

The final gripper worked just the way I had hoped. It could switch between two- and three-finger modes smoothly and adjust to different object shapes with ease.

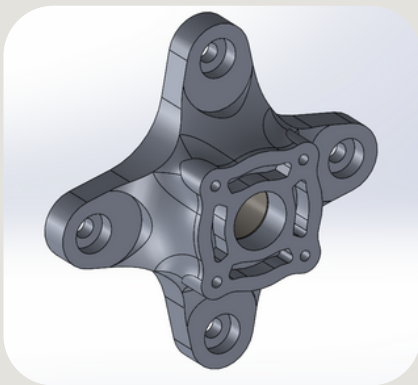


## NJIT Team SAE BAJA

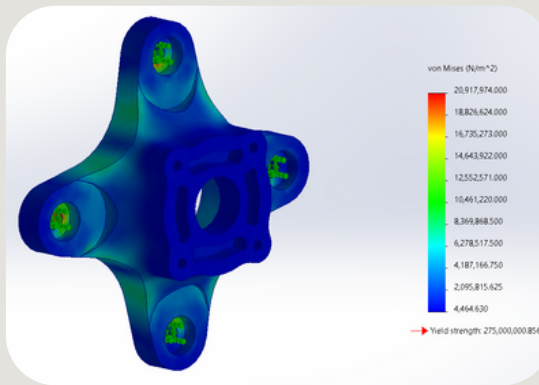
Since 2024, I have been an active member of NJIT's SAE (Society of Automotive Engineers) Baja team, contributing to critical design and mechanical improvements. I played a key role in optimizing the design of the wheel hub, enhancing the strength-to-weight ratio by 15% through strategic material adjustments and structural redesigns using SolidWorks and Onshape. Additionally, I innovated by replacing traditional bearings with sprag clutches, resulting in improved performance and reliability under dynamic loading conditions. Beyond design, I assisted with the precise assembly of the CVT transmission and drive wheel hub assembly, ensuring seamless integration and functionality of the drivetrain system. These contributions not only improved vehicle performance but also strengthened the team's competitive edge in off-road racing conditions.



### Initial Wheel hub Design



### FEA Analysis and design modification



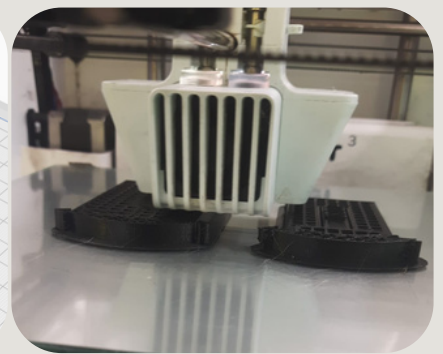
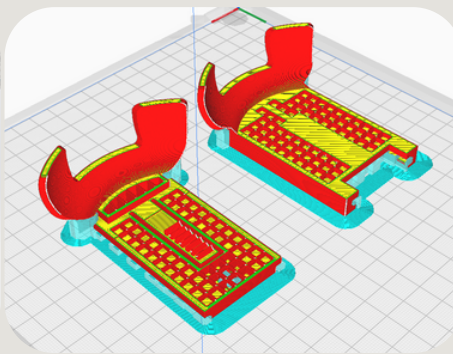
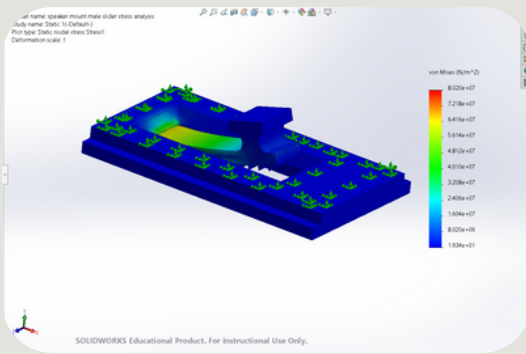
## CAD/3D Printing Application

Solidworks Design and assembly of the mount to test the fitting and tolerances

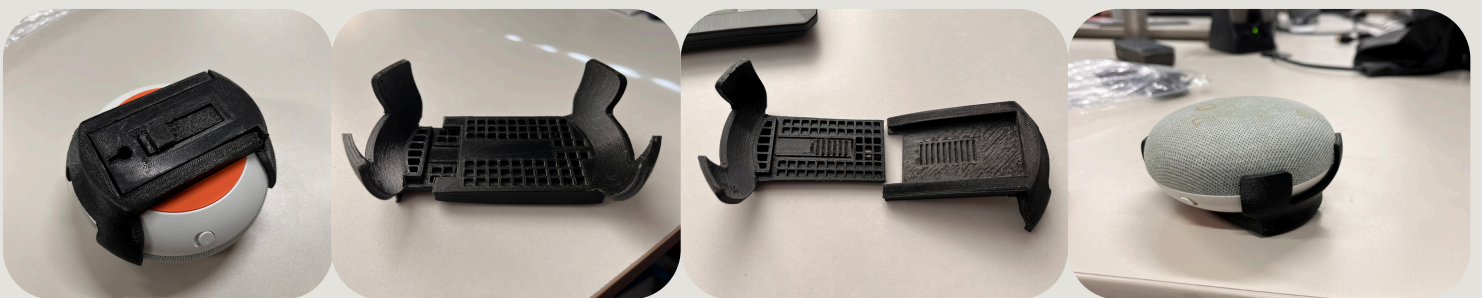


Stress analysis to test the force required to operate Locking Mechanism of the mount with minimum material usage

3D printing setup and actual 3D printing



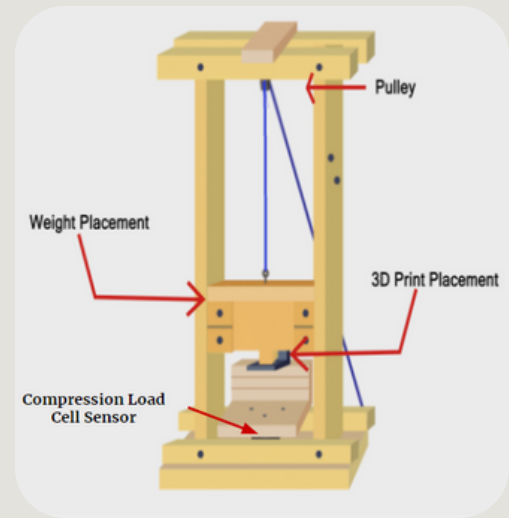
Actual result of 3D printing



I utilized Solidworks, Solidworks Simulation, and 3D Printing to fabricate a speaker mount specifically designed for the Google Home Mini. Leveraging these technologies, I transformed an initial design concept into a functional product. Through precise modeling, simulation, and additive manufacturing, I ensured the mount's compatibility, structural integrity, and optimal performance. This comprehensive approach facilitated the seamless transition from idea to the final, tangible solution tailored for the Google Home Mini.

## Impact Testing Device

Developed an Impact Testing Device: Engineered a custom device to validate the actual impact strength of parts against Finite Element Analysis (FEA) results from SolidWorks. The device was constructed using a durable wooden frame for structural stability and equipped with a load cell to precisely measure impact loads. Programmed and Calibrated Arduino for Data Conversion: Integrated an Arduino to convert raw load cell data into the required impact scale, ensuring accurate, real-time impact measurement. This system enabled precise comparison between FEA simulations and real-world performance, enhancing design validation and structural reliability



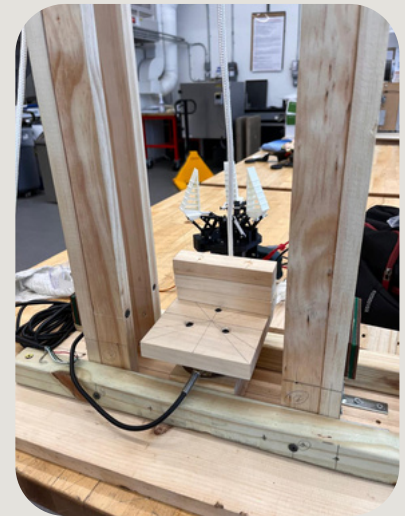
Frame



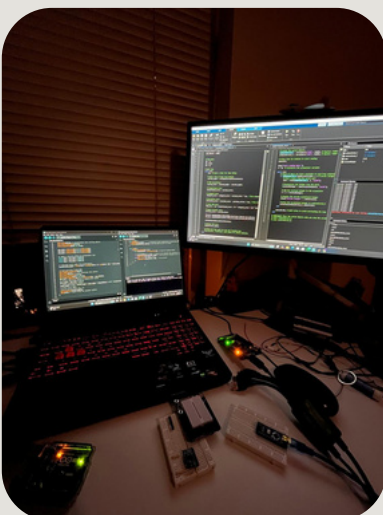
Impact sled



Load cell with test subject holder



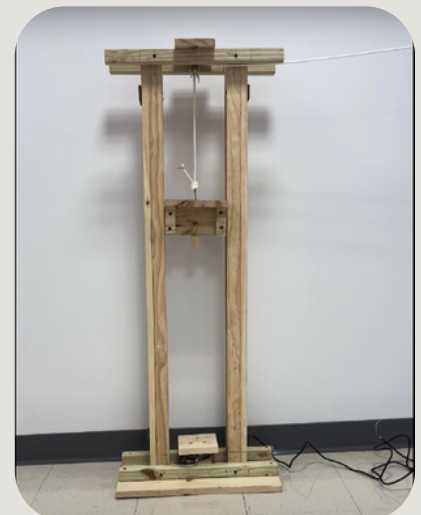
Arduino programming for load cell output



Load cell output after impact



Test Setup



## MagLev Drive: Electromagnetic Levitation and Propulsion System

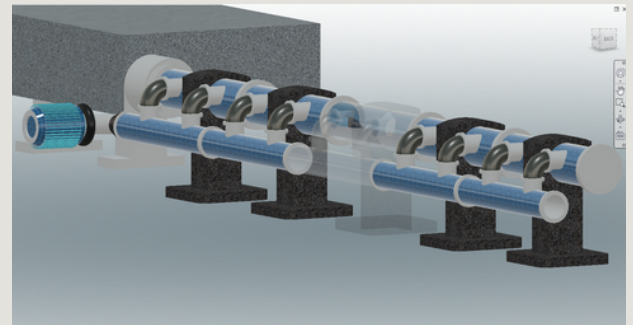
this was my Bachelor's major project. i was following elon musk's hyperloop proposal since it came out in 2013, and wanted to explore the fundamental engineering concepts behind it. through this project i got to learn about concepts of electromagnetic levitation and propulsion.

also gained the understanding of how electricity works and the ways in which we can manipulate it to convert its energy into meaningful output, which in this case is high speed. When Elon Musk unveiled the Hyperloop concept in 2013, something about it immediately captured my imagination. The idea of traveling at near-supersonic speeds using magnetic levitation felt like science fiction—but I wanted to understand the science behind it. That curiosity eventually became the driving force behind my Bachelor's major project. I set out to explore the core engineering behind Hyperloop—electromagnetic levitation and linear propulsion—and turn it into something real. I built a working prototype that featured a 3-phase linear motor for propulsion and a single-phase electromagnetic levitation track. Seeing those principles work in real life, not just on paper, was an incredible moment. It was the first time I truly experienced how theory translates into engineering reality.

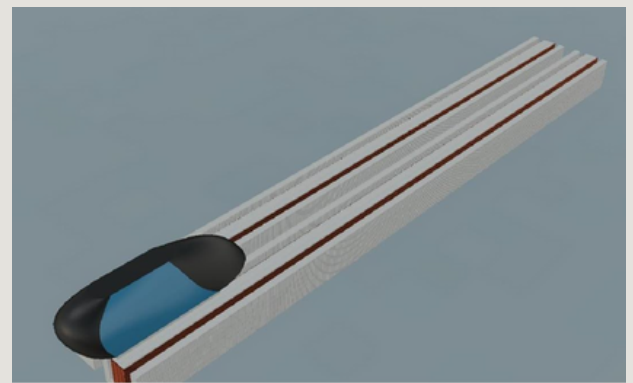
Along the way, I gained hands-on experience with electromagnetism, energy conversion, and motion control. More importantly, I developed a deeper appreciation for how we can shape and control electricity to create meaningful outcomes—in this case, enabling high-speed, contactless motion. This project was more than just a technical challenge; it was a turning point that sparked a lasting interest in transportation systems and mechatronics. It reminded me why I chose engineering in the first place: to turn bold ideas into real, working solutions.



Inspiration

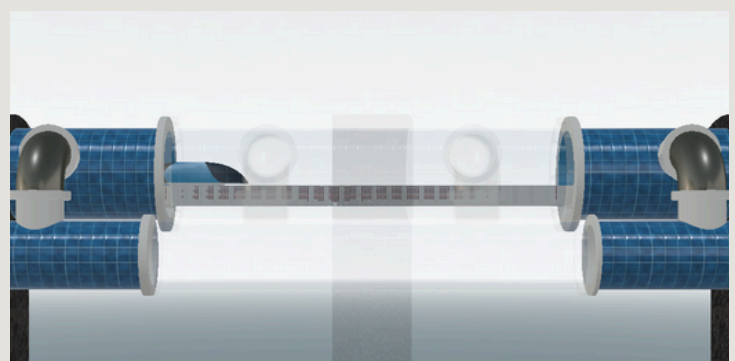


Cad design

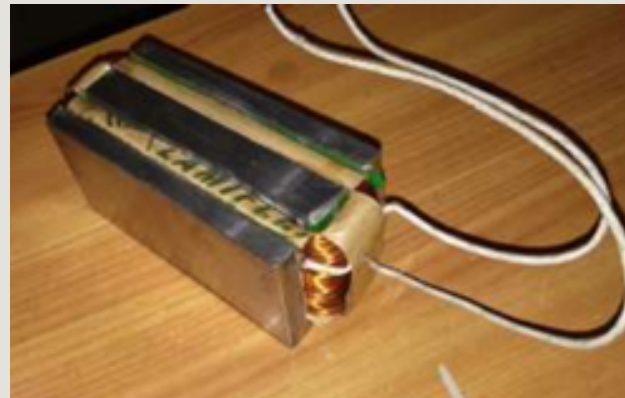


Cad design

Cad design



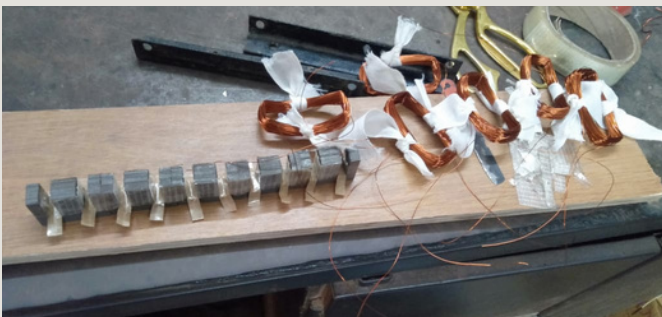
Testing initial levitation with custom machined/built Electromagnet



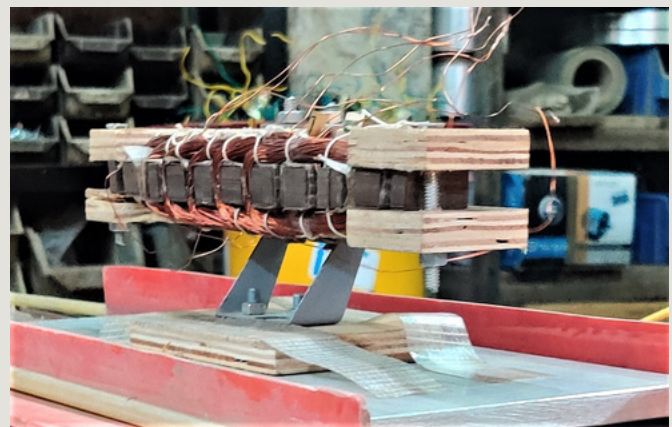
Transformer E-shape core track with copper windings



3- Phase linear motor fabrication for electromagnetic propulsion



Final levitation and Propulsion test

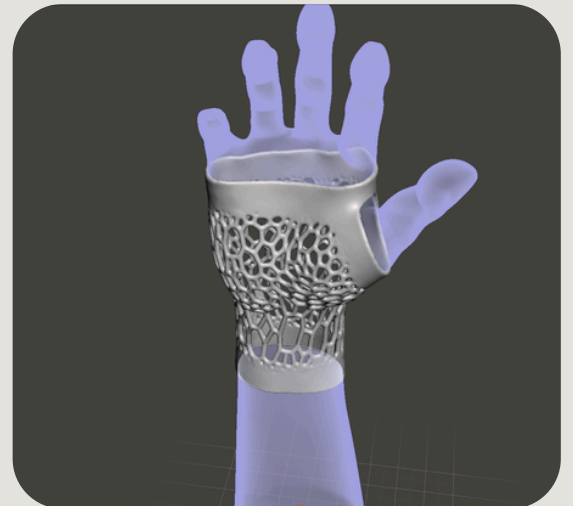


## Meshmixer



Wrist injuries often require braces that are bulky and uncomfortable, leading to poor user compliance. I set out to design a custom ergonomic hand brace that offered both precise fit and comfort, using patient-specific data to improve recovery outcomes.

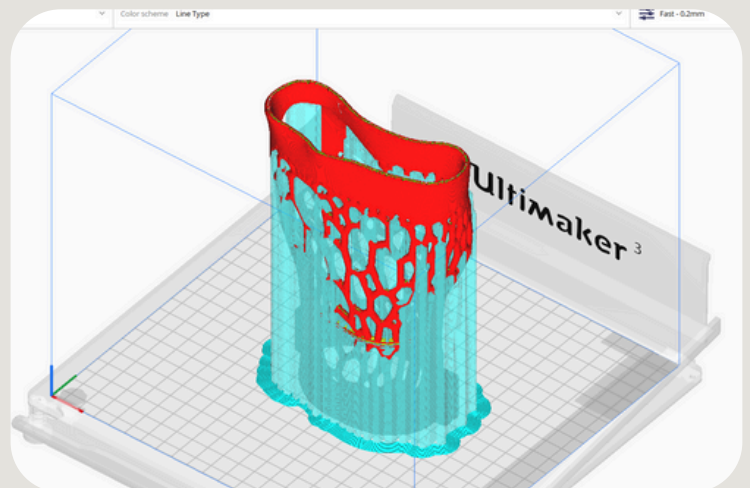
Using Meshmixer, I modeled a brace tailored to the user's wrist anatomy. The design allowed for natural movement, reduced pressure points, and better overall support. The final product was sleek, lightweight, and comfortable, providing a functional, personalized solution that enhanced mobility and improved the healing experience.



**Meshmixer modeling**



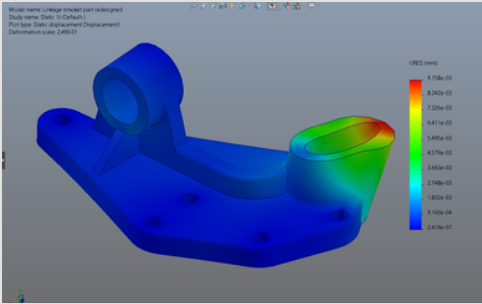
**Solidworks model based on Meshmixer data**



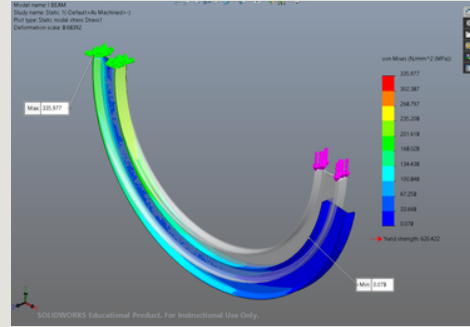
**3D printed file ready for manufacturing**

## Finite element analysis

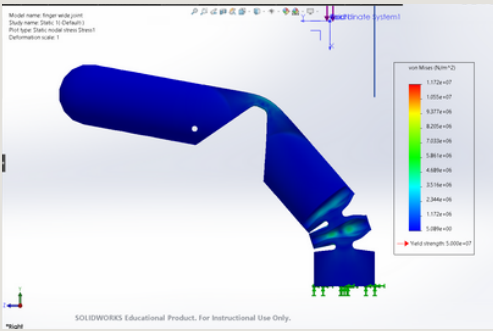
### Dynamic Load Analysis (bearing)



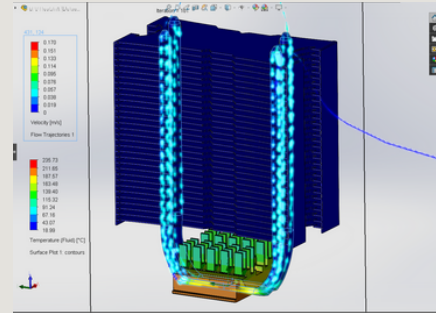
### Buckling analysis of a curved Beam



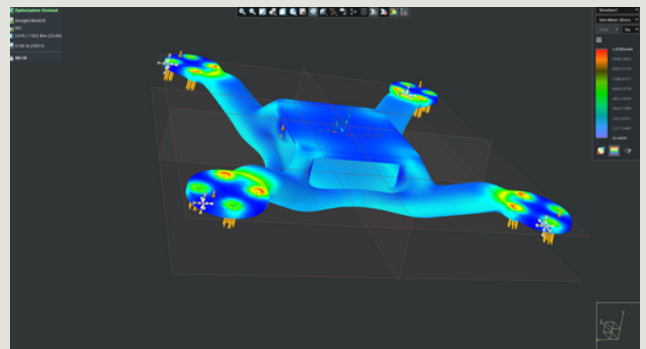
### nonlinear stress analysis of flexible polymer robot finger



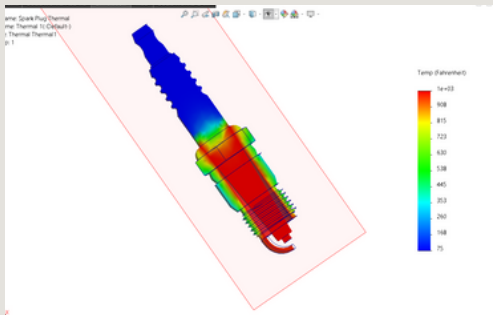
### Flow Simulation through heat exchanger



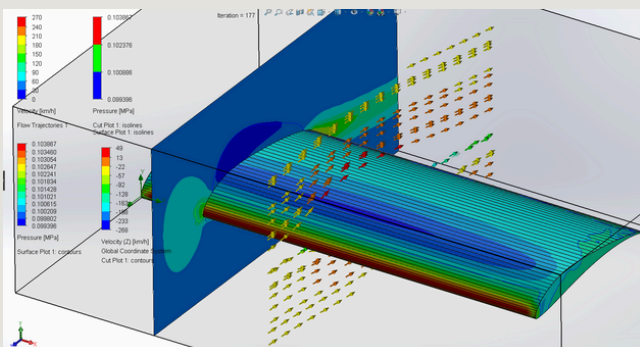
### Topology optimization of a Drone Frame



### Thermal/heattransfer analysis of spark plug



### Flow Simulation over Aerofoil



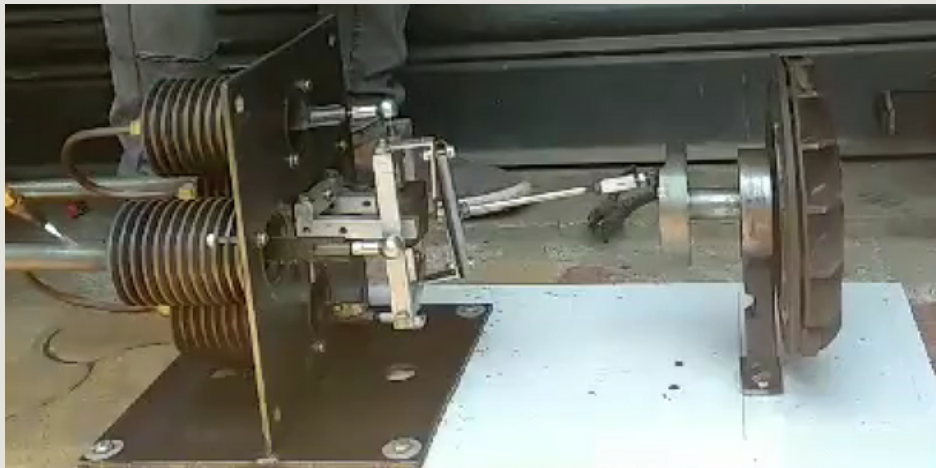
## Stirling engine working mechanism.

Back in my diploma days, I worked on a major project with my team to design and build a Stirling engine. We started off pretty excited — we modeled the whole mechanism in SolidWorks, designed the moving parts and supports, and thought we had it all figured out.

Once the design was done, we jumped into the workshop and started fabricating everything ourselves using traditional machines like the lathe, milling, and drilling tools. It was messy, hands-on, and honestly one of the most fun parts of the project.

When we finally assembled it and tried to run it... it didn't go as smoothly as we hoped. The engine ran, but not very well — we had issues with friction, heat retention, and mechanical alignment. Still, it was a great learning moment. We realized how small design or machining errors can really affect performance, and it gave us a much better understanding of how theory translates (or sometimes doesn't) into real-world results.

Even though the engine struggled, the experience taught me a lot about practical engineering, teamwork, and debugging physical systems — and made me appreciate how challenging it is to bring a design to life.



**Considerable internship experience**

**Automatic assembly machine operator and later assistant machine design engineer**



**Junior Tool room engineer**

**Injection mould Die manifold machining on the Doosan DNM 5700 CNC**



**injection mold Die Core machining on Wire cut  
Electric discharge machining (EDM)**

**Injection mold Die  
complete assembly**

