Hussein Shata

Robotics Engineering Portfolio

Introduction/Background

- Currently pursuing my PhD in the Mechanical & Aerospace Engineering department at Rutgers University, The State University of New Jersey.
- Specializing in 5G data transmission, Cloud Computing, Machine Learning, and Computer Vision.
- This portfolio is designed to supplement my resume by demonstrating my Engineering project experiences, and skills I earned throughout my engineering degrees.

Publications

Journal Papers:

[J1] **ElHussein Shata**, Kim-Doang Nguyen, Praneel Acharya, Jeffrey Doom, "*A Series-Elastic Robot for Back-Pain Rehabilitation*," International Journal of Control, Automation and Systems. October 2021.
URL: https://link.springer.com/article/10.1007/s12555-019-0859-x

Conference Papers:

[C1] **ElHussein Shata**, Praneel Acharya, Kim-Doang Nguyen, "*Brachiating Robot Analysis and Design*," IEEE International Conference on Electro/Information Technology, May 2019.
URL: https://ieeexplore.ieee.org/abstract/document/8833849

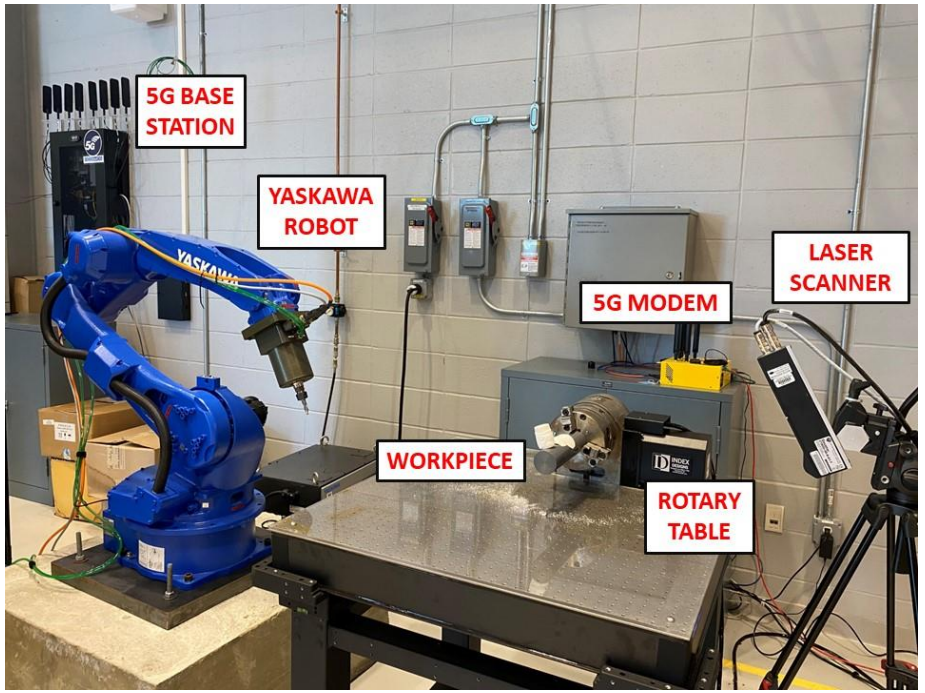
[C2] **ElHussein Shata**, Praneel Acharya, Marco Ciarcia, Kim-Doang Nguyen, "*Optimization of a Chemical Reaction Using the Modified Quasilinearization Algorithm*," IEEE International Conference on Electro/Information Technology, May 2019.
URL: https://ieeexplore.ieee.org/abstract/document/8833909

[C3] Praneel Acharya, **ElHussein Shata**, Kim-Doang Nguyen, "*Motion Planning for Nonprehensile Manipulation*," IEEE International Conference on Electro/Information Technology, May 2019.
URL: https://ieeexplore.ieee.org/document/8834164

Others:

GitHub: https://github.com/hshata
My Thesis: https://openprairie.sdstate.edu/etd/3930/
My YouTube Channel: https://www.youtube.com/channel/UC49RY4r2ZZHDXZlzZjPdSag
My LinkedIn: https://www.linkedin.com/in/husseinshata/

My PhD Research:
Robot Control via 5G
(Industry 4.0)



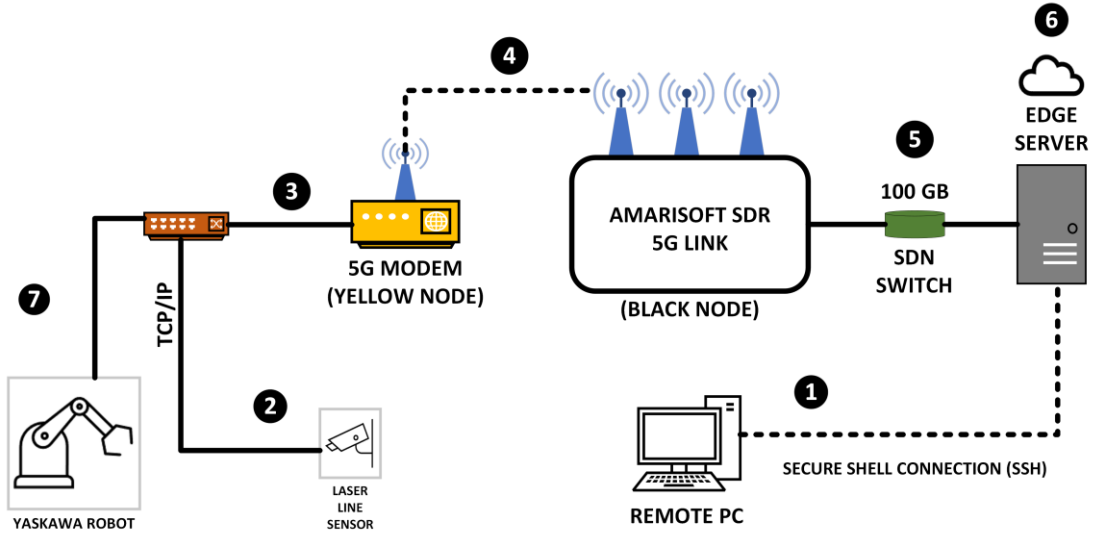
Goal
Exploring Advanced manufacturing methods for industry 4.0

Description

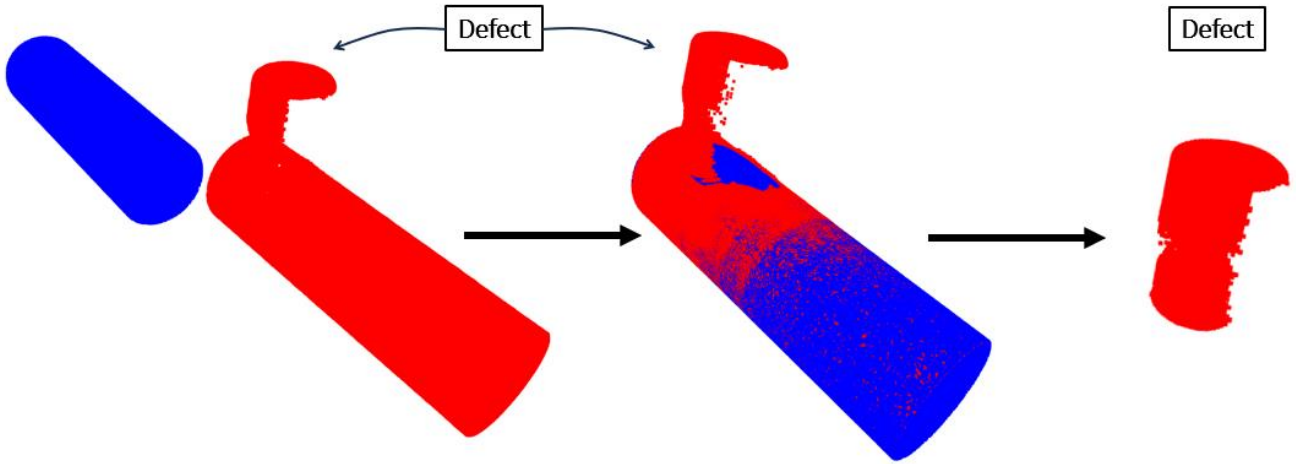
- Utilizing a 5G network for smart manufacturing
- Control of YASKAWA 6 DOF Robot for milling procedure and over 5G network
- Exploiting cloud-based robot control

Tools used: Linux, Cloud Computing, BASH, PowerShell, Python

Video Link:
https://youtu.be/-FtM3oyed5w



Defect Detection Using Iterative Closest Point (ICP) and cKDTree



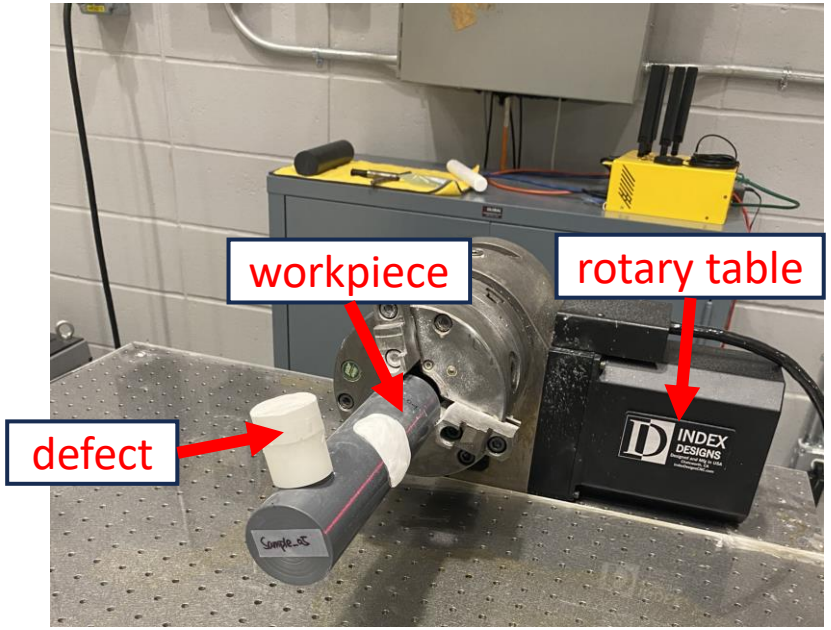
Goal

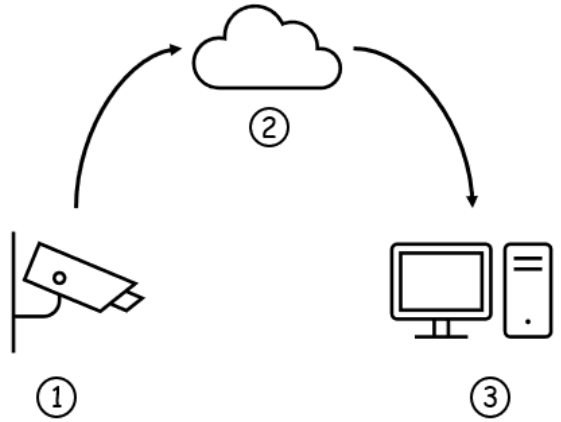
3D Point Cloud Defect Identification

Description

- Utilizing a LiDAR Scanner to collect geometrical data of a workpiece
- Processed these data using ICP algorithm to align a predefined model with the scanned data
- Identified defective parts using cKDTree algorithm

Tools used: Gocator LiDAR sensor, Python





SmartGate® Modeling and Simulation

Goal

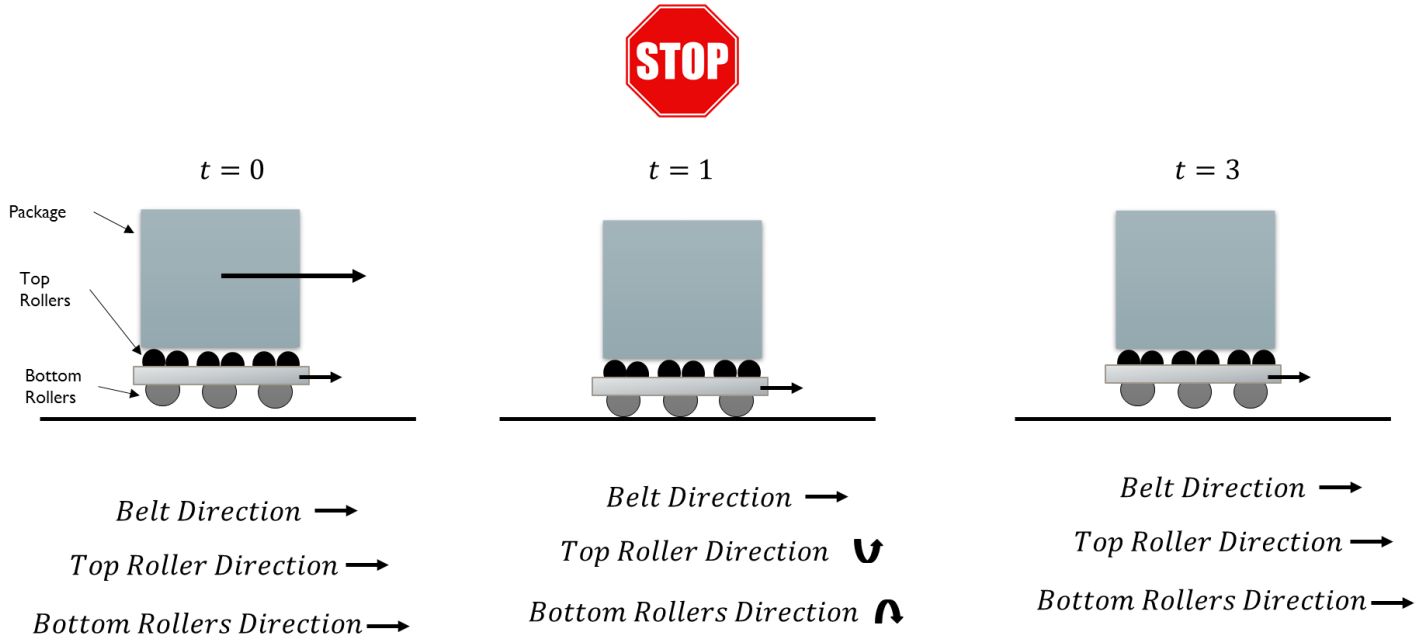
Model and Simulate the SmartGate® conveyor line.

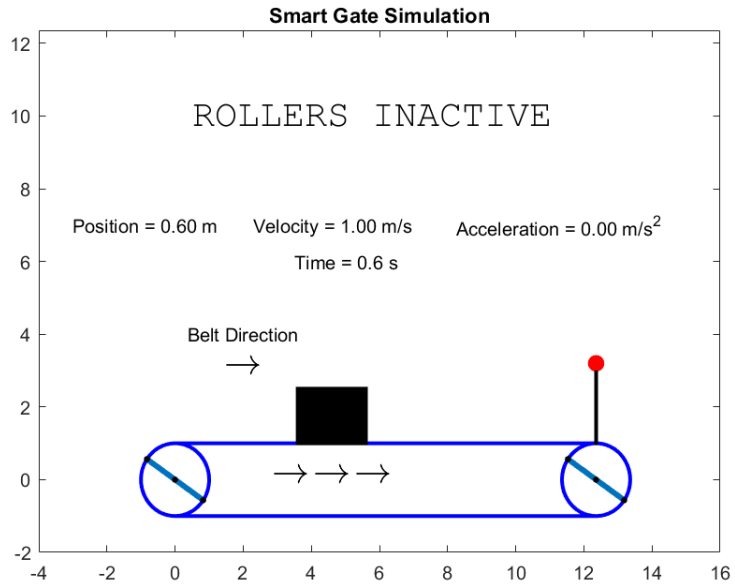
Description

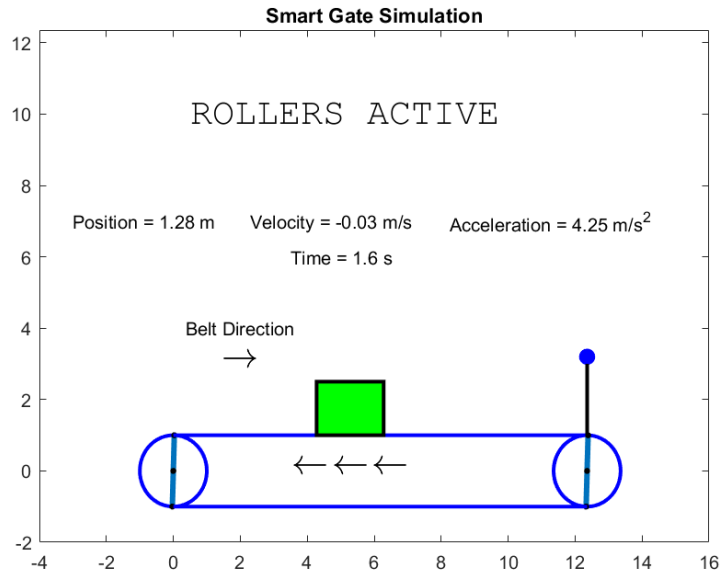
- A conveyor belt that is designed to keep packages stationary while belt is moving
- Mathematically modeled the dynamics and kinematics of the SmartGate®.
- Used MATLAB for implementation and created animations to further study the system.

Tools used: MATLAB

Video Link:
https://youtu.be/eM5skVqwh-U







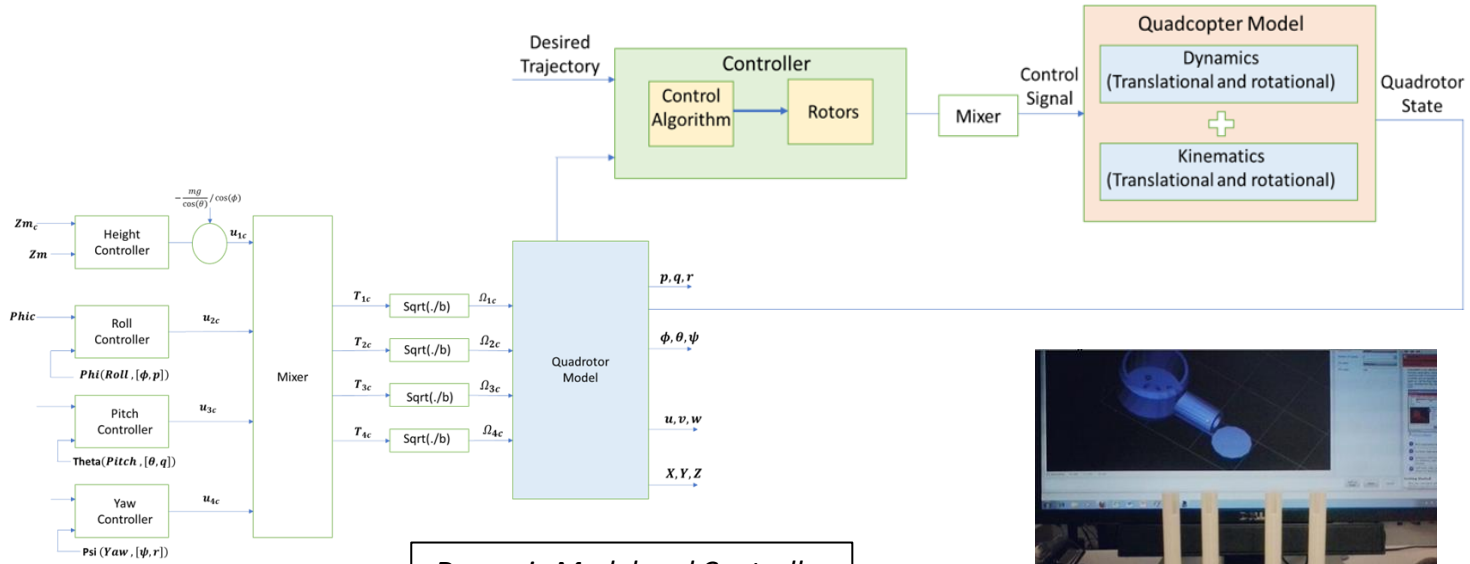
Quadrotor Dynamics

Goal

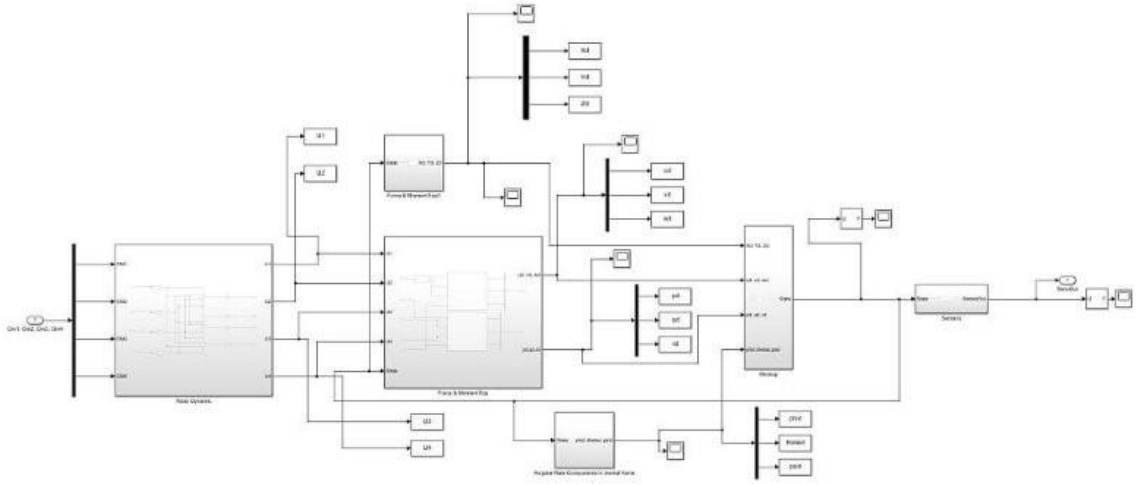
Design, fabricate, and control of an Unmanned Aerial Vehicle (UAV).

Description

- Implemented the full dynamics of quadrotor on Simulink
- Designed a PID controller for position tracking
- Designed, installed, and programmed the UAV circuit components.
- ***Tools used:*** MATLAB, Simulink, 3D Printing



Dynamic Model and Controller



An overview for the system model dynamics

Assembled quadrotor

Neural Network With Backpropagation Algorithm

Goal

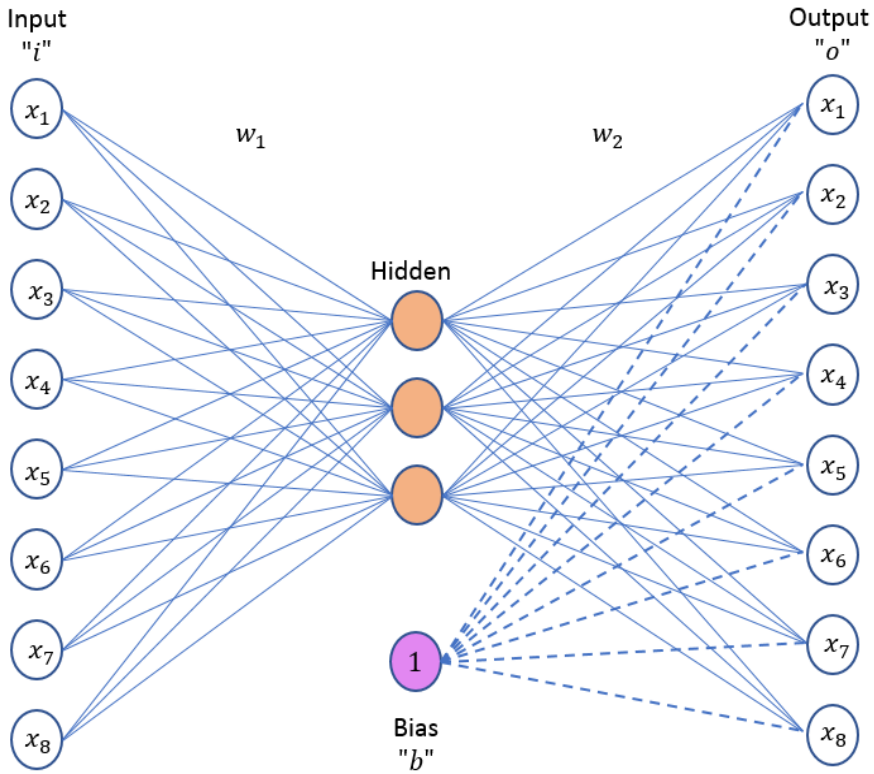
Implement an 8-3-8 Multilayer Perceptron Neural Network with Backpropagation algorithm.

Description

- Architected an 8-3-8 NN
- The input of the NN, a set of eight binary numbers that goes from one to eight
- Utilized back propagation algorithm in the implementation

Tools used: MATLAB

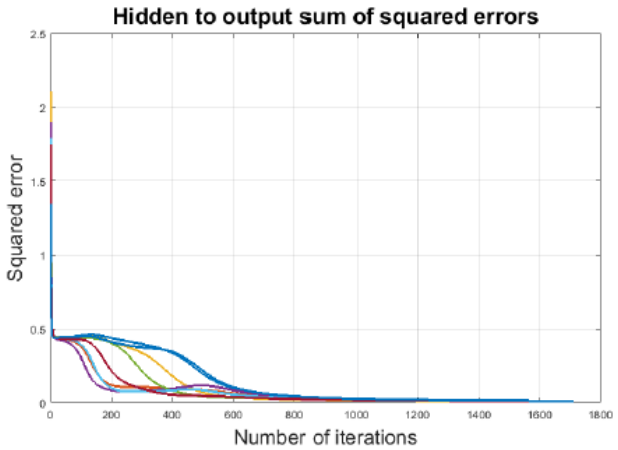
Project Link:
https://github.com/hshata/NeuralNetwork



The used Neural Network model with eight inputs, three hidden, and eight output layers

x_i	INPUT	DESIRED OUTPUT
x_1	10000000	10000000
x_2	01000000	01000000
x_3	00100000	00100000
x_4	00010000	00010000
x_5	00001000	00001000
x_6	00000100	00000100
x_7	00000010	00000010
x_8	00000001	00000001

Where x_i is the binary input



Sum of squared errors

My Masters Thesis:
Back-Pain Robotic Rehabilitator

Goal

Develop a full-scale model of the Series Elastic Actuator to be integrated in clinical trials for back-pain rehabilitation.

Description

- Designed a SEA with two springs, gears, and stepper motor
- Fabricated a full-scale model and installed it on a sit-up bench
- Used Arduino, stepper motor driver, and encoder to send feedback and control the mechanism

- ***Tools used:*** SolidWorks, MATLAB, Arduino

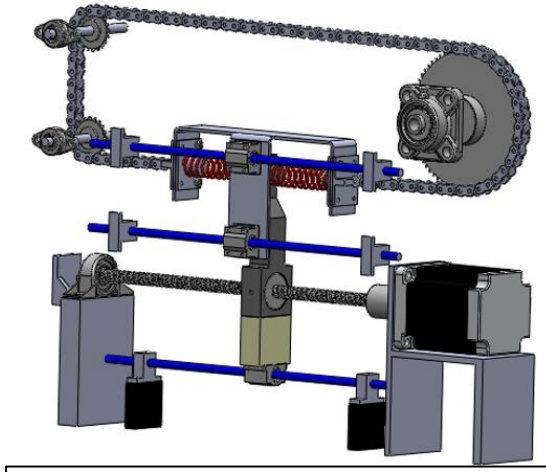
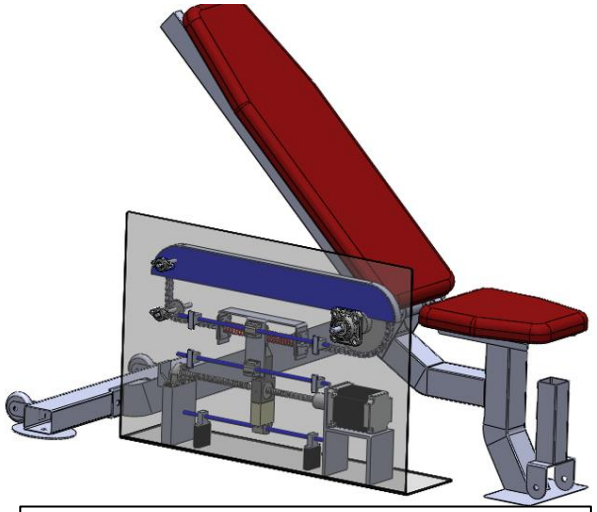
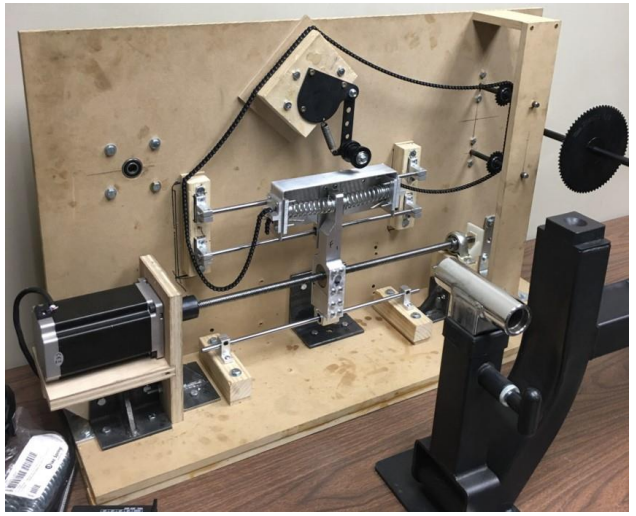


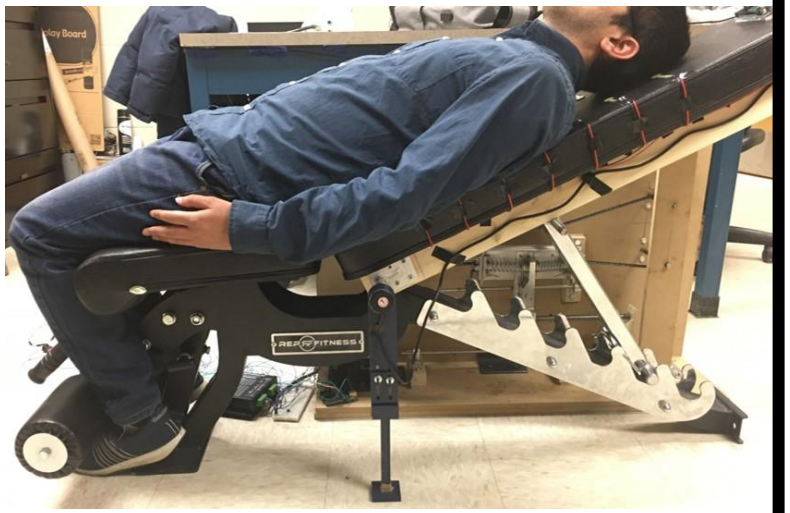
Illustration of the driving mechanism



Full-size CAD model



Fabricated full-scale model



Human subject setup and apparatus

Arboreal Brachiating Robot

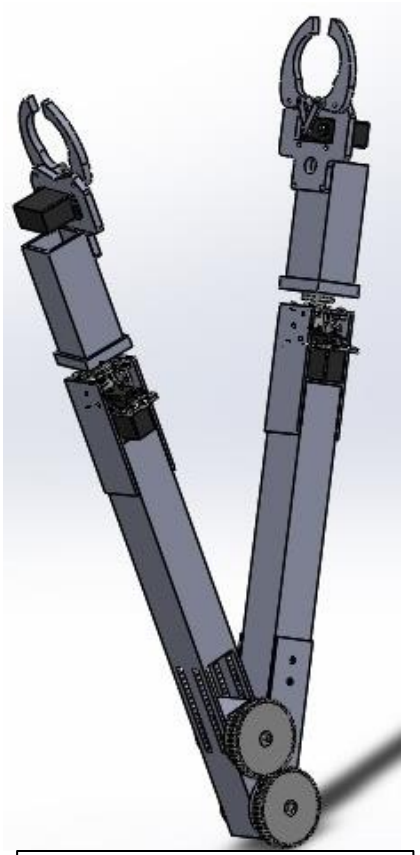
Goal

Create a mechanical system that mimics gibbons' motion for bridges' inspections.

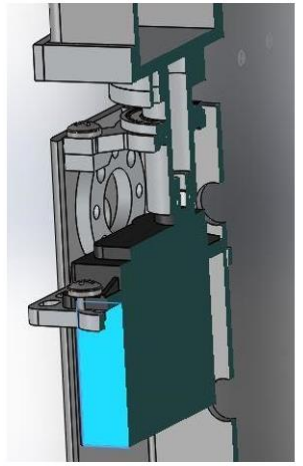
Description

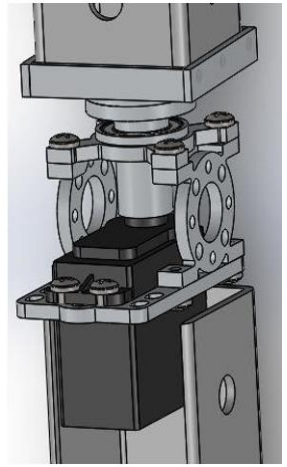
- Designed and fabricated a two-bar linkage to reduce the complexity and weight of the mechanism
- A wrist mechanism is designed to ensure the dexterity of the mechanism.
- Used two gears and a DC motor with encoder for motion control via Arduino

Video Link: https://youtu.be/347pvghNKUE

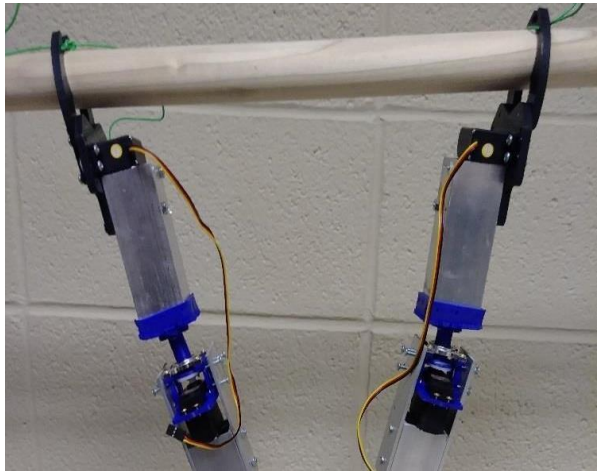


Two-bar linkage design





Wrist mechanism CAD



3D printed grippers and wrists

Fully fabricated mechanism

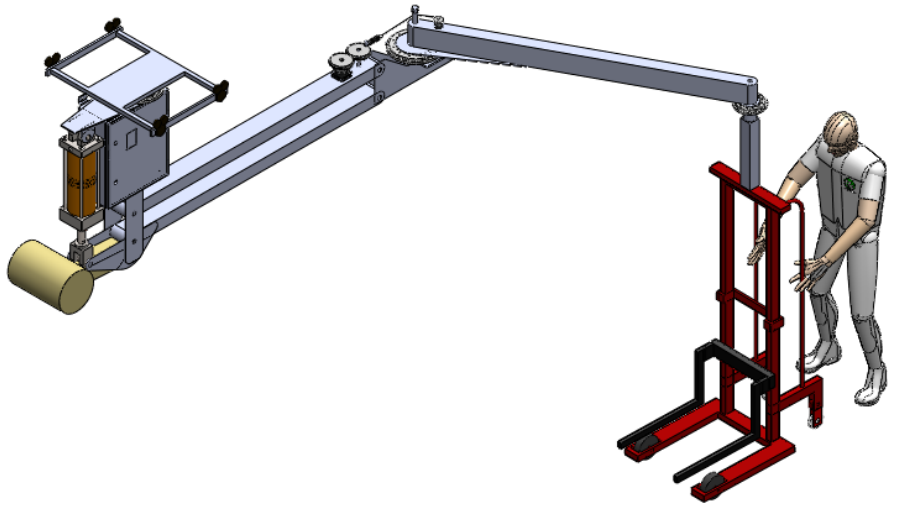
Material-handling Manipulator *(Concept)*

Goal

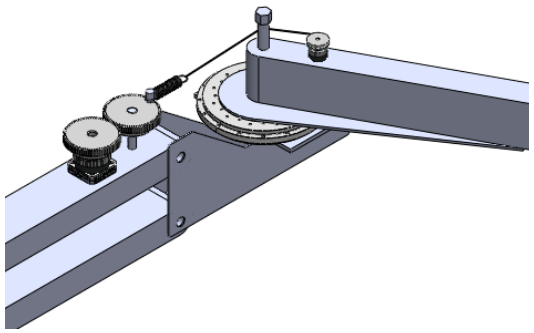
Design a Variable Stiffness Actuator (VSA) for safe material handling manipulator.

Description

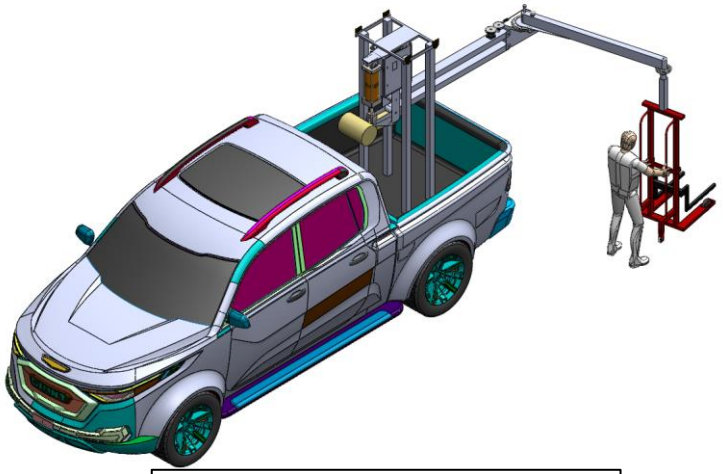
- Designed a flexible ceiling robotic arm with a forklift end-effector and a hydraulic press
- Deployed a VSA with two servomotors and a spring to variate the stiffness
- The mechanism can be portable by mounting it to a pickup truck



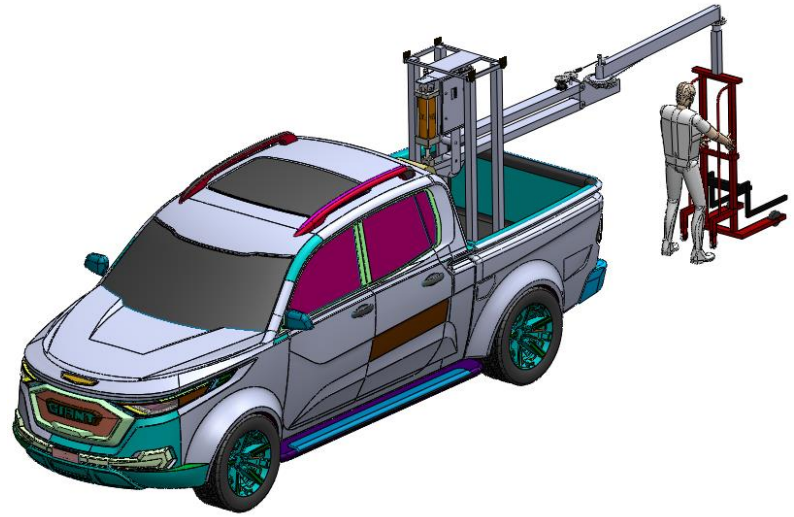
Material-handling Manipulator



Flexible joint illustration



Manipulator on a pick-up truck



Manipulator working space

Coursework Background

Graduate:

- Computer Intelligence
- Robotic Systems
- Nonlinear Programming
- Linear Control Theories
- Modeling and Simulations
- Engineering Mechanics in Biomedical Applications
- Automatic Control
- Computer Vision
- Mechatronic Automation
- Computer Aided Engineering

Undergraduate:

- Machine Design
- Engineering Mechanics
- Thermodynamics I - II
- Heat transfer
- Statics, Dynamics
- Physics
- Calculus I - III
- Differential Equations
- Mechanics of Materials
- Advanced Engineering Mathematics
- Vibration

Software Skills:

- MATLAB
- Simulink
- Python
- ROS
- Inventor Autodesk
- SolidWorks
- Studio5000
- TwinCAT