VIDIT PANDYA | PROJECT PORTFOLIO

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CURRENT/ONGOING PROJECTS

1. **Simulation and Modeling of Turbulent Flow at Porous/Fluid Interface** *(Jan 2022 -)*

- Currently working on a simulation of turbulent flow in composite porous/fluid channels to identify the influence of the thickness of the porous layer on the micro-scale turbulence, with the research group at the Computational Bio-fluids and Heat Transfer Lab at NCSU.
- The research involves the use of software such as ANSYS Fluent, Tecplot for CFD/Post CFD, and computational resources such as NCSU's HPC (High-Performance Computing).
- The study has application in many porous/fluid interactions around us such as forestry (forest fires), chemical and nuclear reactor design, agricultural engineering, catalytic converters, bio-filters, crude oil extraction, biomechanics of porous organs, and many others.

2. **Automation of PCB inspection using Convolutional Neural Network-based Image Processing** *(Jan 2022-)*

- Presently working towards the development of a PCB inspection setup that is completely automated with the objective to eliminate the time-consuming manual inspection processes in industries, as a part of a funded course project at NCSU.
- The idea is to run a convolutional neural network deep learning model on an edge device (raspberry pi) integrated with real-time image capture, to classify and reject the PCBs that are defective using a linear actuator.
- The project is also aimed at being able to successfully identify the security threats and counterfeit components on a PCB board.
- The model is being developed in Python using the Tensorflow framework, and on successful training and debugging, it will be converted to the Tensorflow Lite framework for faster and efficient processing on the edge device.

COMPLETED PROJECTS

1. **Comparison study of n-D Design Optimization algorithms** *(Sept-Dec 2021)*

- Implemented analytical and optimization algorithms such as Gradient Descent, Fletcher-Reeves, BFGS, and Simulated Annealing for a complex spring-mass system to find equilibrium positions for random release points.
- Analyzed performance and computational cost by creating solvers in MATLAB and compared the results to investigate the application-based classification and generated a list of optimal parameters for each algorithm.
- It was observed that for a problem like this, although metaheuristics such as simulated annealing give a promising result, the most efficient and economic algorithm is still BFGS in finding global optimum for single objective unconstrained optimization.

2. **Modeling and numerical simulation of spacecraft attitude dynamics and gravity gradient moments** *(Sept-Dec 2021)*

- Derived and performed comparison of linear and non-linear models of attitude dynamics and gravity gradient moments to analyze stability condition of aircraft on linearization and determine its error function.
- Illustrated numerical simulations for the same using MATLAB to visualize the divergence of linear and non-linear models with and without the consideration of gravity gradient moments.
- From the simulations it was observed that gravity gradient influence cannot be neglected in lower earth orbits and divergence of the linear model has a raising tendency as a function of increasing attitude angles, and hence these results must be considered while designing attitude control subsystem for a space-craft.

3. **Investigating the bi-directional Axonal transport of Alpha-Synuclein protein in the human body** *(Sept-Dec 2021)*

- Examined mathematical models for Axonal transport from the Soma to Synapse against the concentration gradient, of the Alpha-Synuclein protein (suspected cause of Parkinson's disease) inside a nerve cell.
- Inspected the effects of changing the axonal parameters such as half-life, anterograde and retrograde velocities, axon length, and boundary conditions such as concentrations at soma and synapse via graphical simulations using MATLAB.

- From the study, it was observed that realistically lower values of the half-life of alpha-syn monomers allow better quantification of flux information across boundaries.
- It was also observed that changing the logistic constant in the cost function used to predict best-fit kinetic constant values had a significant impact on how well the model simulated the alpha-syn transport phenomena.

4. **Modification of Pneumatic Crimping Machine for higher efficiency and reduced lead time** *(Nov –Dec 2021)*

- As a part of my role at Banco Product India Ltd., worked with the maintenance team on reconfiguring the pneumatic system of an assembly line crimping machine.
- Designed optimal paths for efficient air pressure delivery to the various cylinders by rerouting the existing lines and using a combination of flow control valves, as well as an "efficient model setting" method to reduce the radiator model setting time by designing an adjustable fixture.
- On implementation, a 16% reduction in the cycle time of the machine per radiator was observed.

5. **Machine Cost-Effectiveness Study to optimize new technology procurement decisions** *(Feb-Apr 2021)*

- As a part of my role at Banco Product India Ltd., analyzed past data for annual operational and maintenance costs for each machine per operating hour to observe trends that drive new machinery procurement decisions.
- The aim of this analysis was to focus on which performance metrics are the lowest in the current technology to be able to select/customize the replacement correspondingly, and to stop any unreasonable expense in terms of operation and maintenance.
- The outcome of this study provided meaningful suggestions for procurement of industrial lifting equipment which ultimately led to an overall cost saving of approximately 7,00,000 INR.

6. **Reconfigurable Quadruped Robot with Ball Screw Actuation** *(Sept 2019 – Aug 2020)*

- Led a team of 3 to develop a four-legged reconfigurable robotic system that possesses substitution in locomotion (trot-roll) depending on terrain information.
- A design based on ball screw actuation allowed for a higher tolerance for error ultimately resulting in a simplistic control model, along with the unique capability of switching to wheeled locomotion on smoother terrain.
- Formulated 3D and mathematical models for the design's kinematics and rigid body dynamics, and analyzed the structure using tools such as Creo and ANSYS.
- Awarded funding from Student Startup and Innovation Policy of INR 30,000.

7. **Study of a Radical Exhaust Air Purification system** *(Sept 2018- Apr 2019)*

- Led a team of 5 for theorizing a system for scrubbing oxides of carbon and sulfur using aqueous mono-ethanolamine solvent from industrial exhaust streams and converting the saturated solution to byproducts such as carbon-based inks and sulfur-based agricultural products (insecticides, fertilizers).
- The system consisted of a hybrid solar refrigeration scrubbing unit to maintain low temperatures at which it becomes possible to activate the absorption process.
- Created process flow diagrams and discussed environmental merit based on regional industrial emission statistics.

FUTURE/POTENTIAL PROJECTS

8. **Model Predictive Control for a MIMO Spherical Motor design**

- Interested in taking the initiative to model an MPC system for an existing Spherical Motor design at the Electro-mechanics Research Lab at NCSU.
- The complexity of the problem presents an exciting learning curve as it would allow me to explore various facets of control systems and electro-mechanical principles deeply.

9. **Application of AI/ML to Mechanical/Industrial problems**

- Highly interested in taking up projects where I can implement Machine Learning tools and techniques to improve the performance of mechanical systems in a variety of domains.