Bhavesh Parkhe

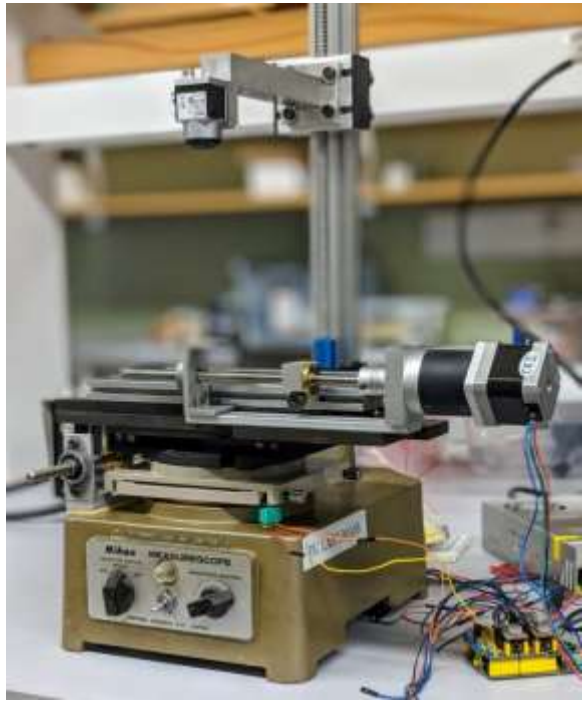
2020 ENGINEERING PORTFOLIO

bparkhe.github.io

01
MICROSCOPE FEEDBACK CONTROL

JAN 2020 – FEB 2020
Intelligent Sensing Lab

At the Intelligent Sensing Lab, under the guidance of Prof. Xian Du, we seek novel sensing and control techniques for high precision equipment which find applications in the life sciences industry.

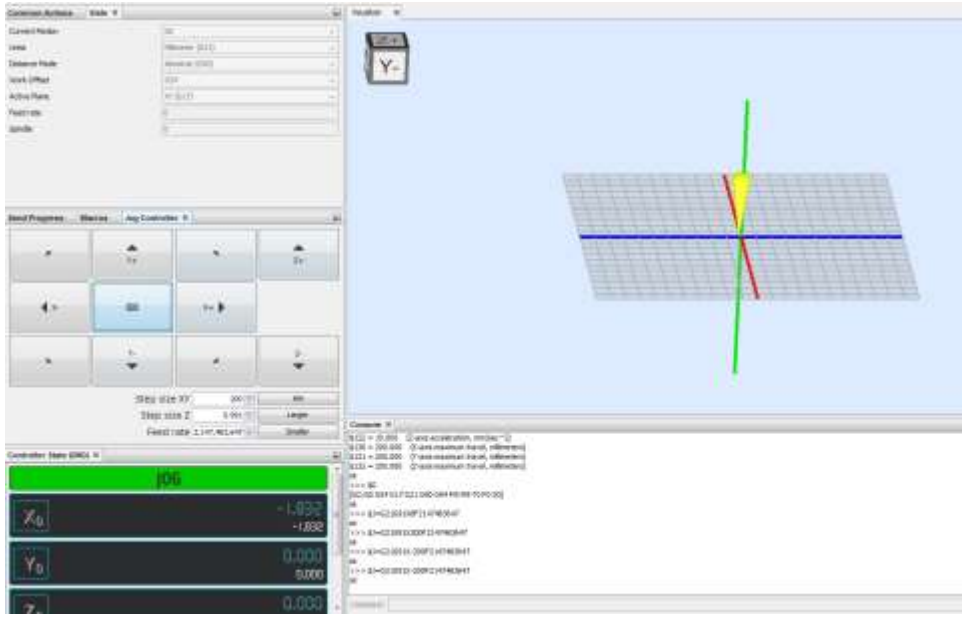


Interfaced X & Y Axis stepper motors with Arduino for table position feed input

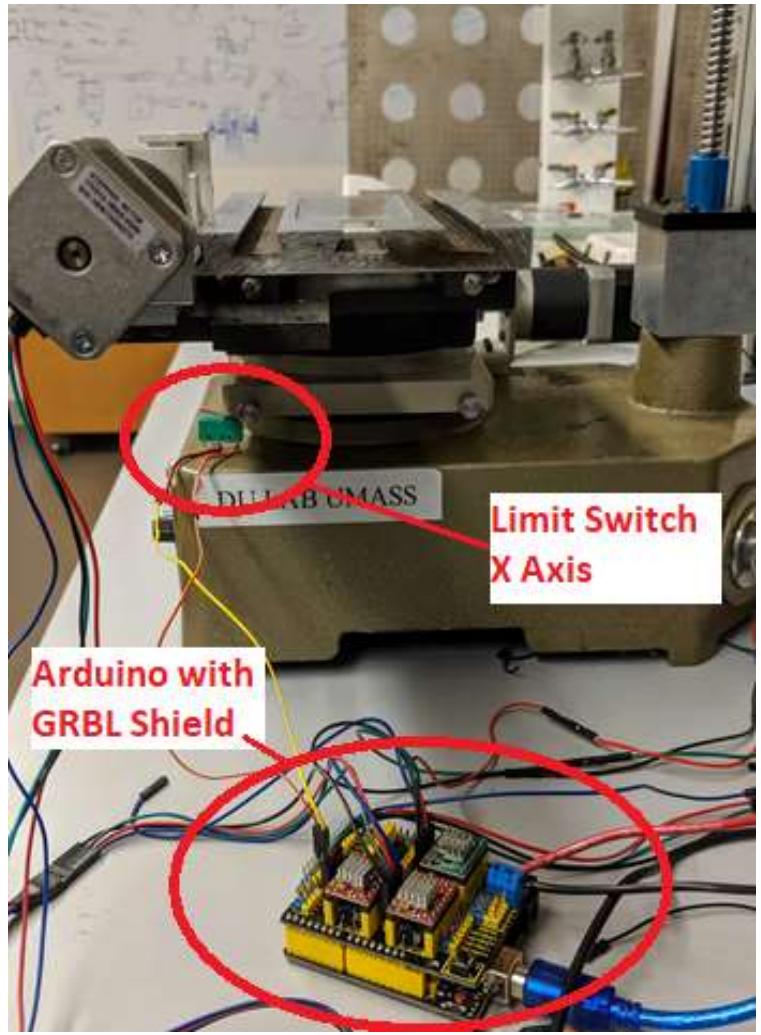
Project Summary

Major 3D printing and scanning equipment are open-loop with local feedback prone to hysteresis and error due to steps skipped by stepper motor. Purpose of this project is to study methods for high precision position control of motorized table of a Nikon measurescope for OCT scanning.

- Interfaced GRBL open source platform to make Arduino compatible with CNC G-code commands
- Installed limit switches for home position reset
- Future work involves experimenting with sensor fusion for improving position feedback



Setup Universal G-code Sender for communicating with the GRBL



Setup Arduino with GRBL shield and installed limit switch for home position

02
VEHICLE MOTION CONTROL

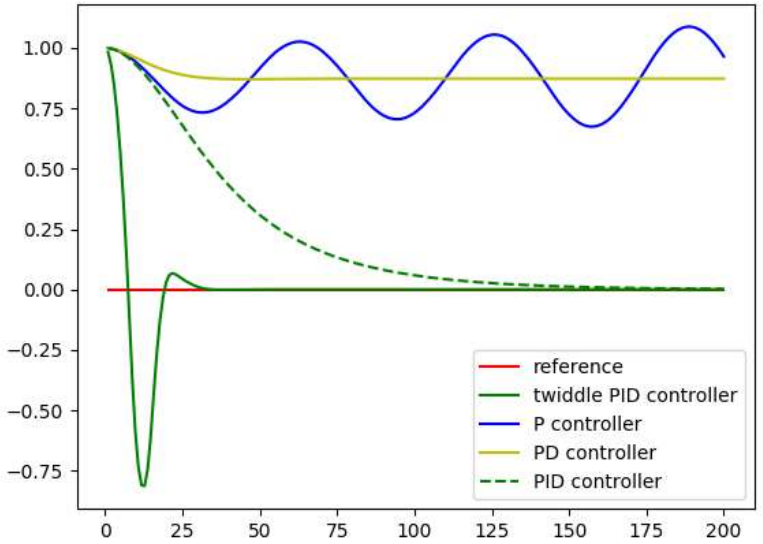
OCT 2019 – JAN 2020
Udacity Autonomous Vehicle Nanodegree

The Autonomous Vehicle Nanodegree is aimed at training engineers to implement algorithms used presently in the booming self-driving car industry. These algorithms also find extensive applications in robotics and industrial automation.

Project Summary

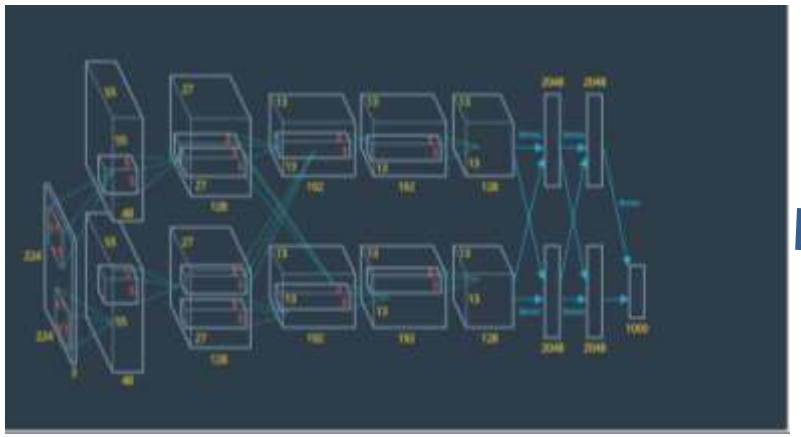
1. Model Based:
- Used camera inputs to estimate lane offset which is fed to PID controller to estimate steer angle
- Implemented the twiddle algorithm to learn PID coefficients in real-time for the car driving autonomously in simulator and use them simultaneously to stay in lane

2. Data Based:
- Using Neural Networks and Transfer Learning approach, I defined steering behavior based on training images
- Trained the neural network by driving around the simulator and capturing images for different maneuvers
- Used the trained neural network pipeline to estimate steering angle on test run and keep vehicle in lane



Estimated the coefficients for the PID control in real-time using twiddle algorithm

Input training images to neural networks with the associated steering angle



Trained a Neural Network similar to Googlenet with multiple convolution and max pooling layers
(image for representation)

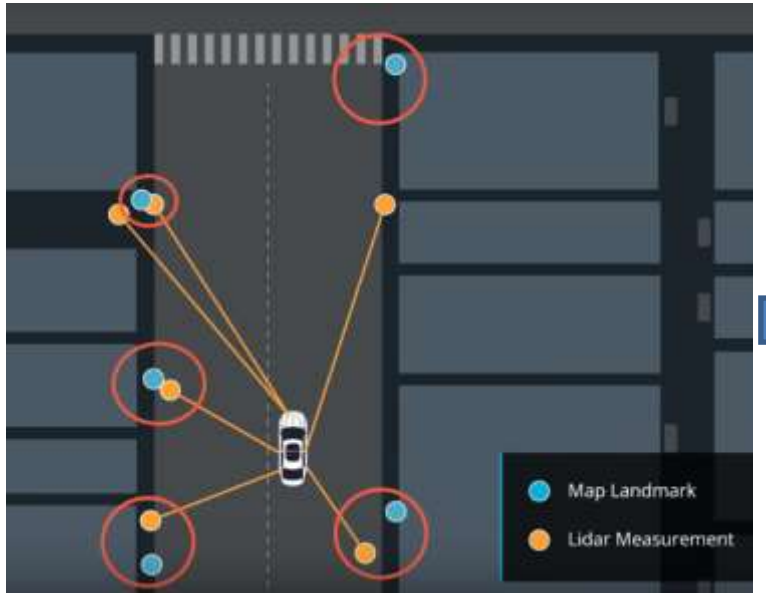
Implemented both algorithms in simulator to autonomously control lane keeping motions

03
SENSOR FUSION & LOCALIZATION

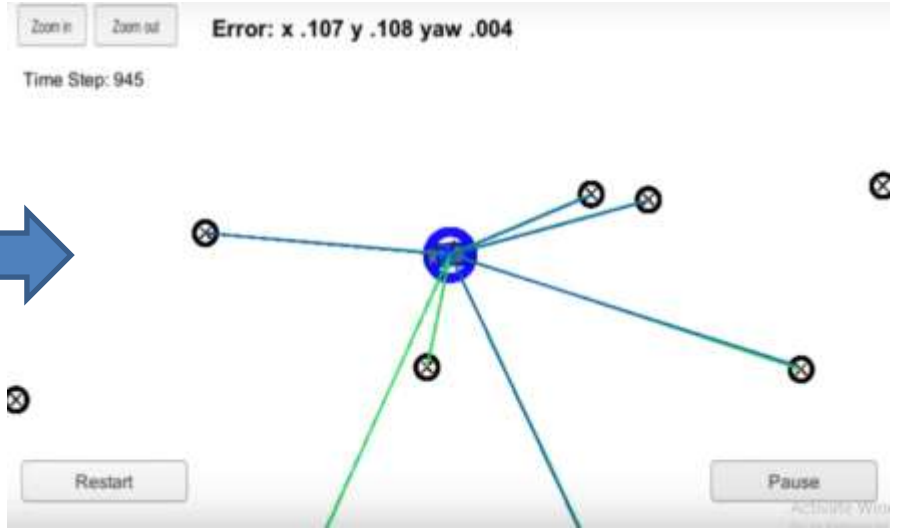
DEC 2019 – JAN 2020
Udacity Autonomous Vehicle Nanodegree

1. Sensor Fusion:
Fused local Radar and Lidar position estimates using Extended Kalman Filter to a singular local value.
2. Localization:
Used inputs of surrounding map landmarks to estimate vehicle position

Localization

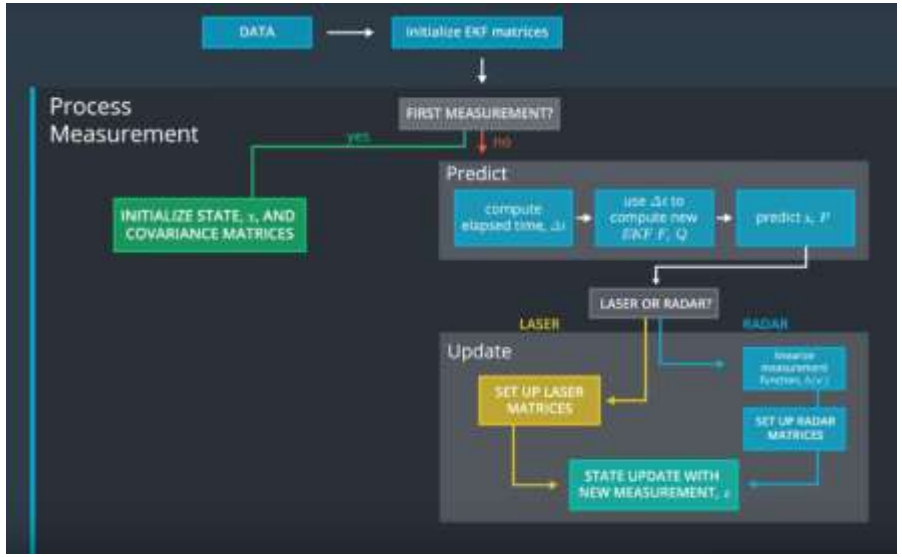


Used Nearest Neighbor approach for associating map landmarks with Lidar/Radar datapoints

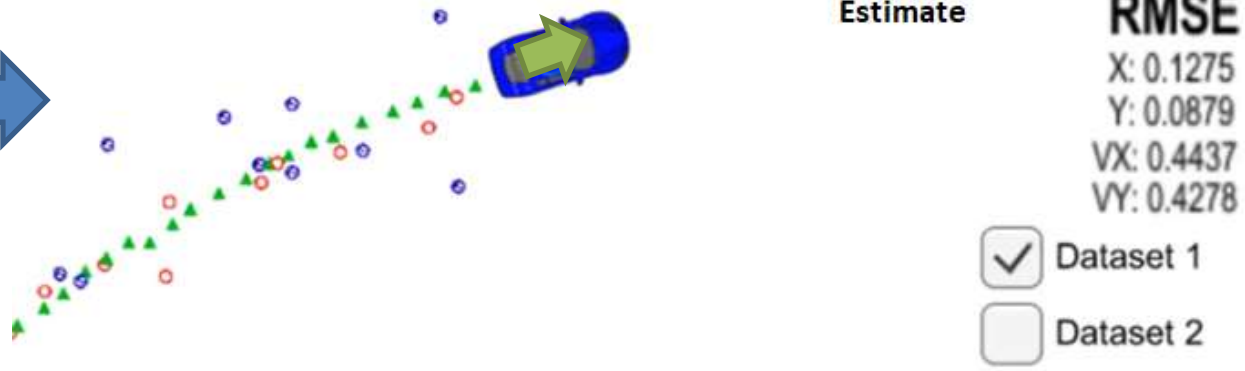


Performed localization on vehicle simulator using Particle Filter Algorithm

Sensor Fusion



Implemented Extended Kalman Filter pipeline in C++



Estimated Vehicle position in simulator using input Lidar and Radar data of local checkpoints

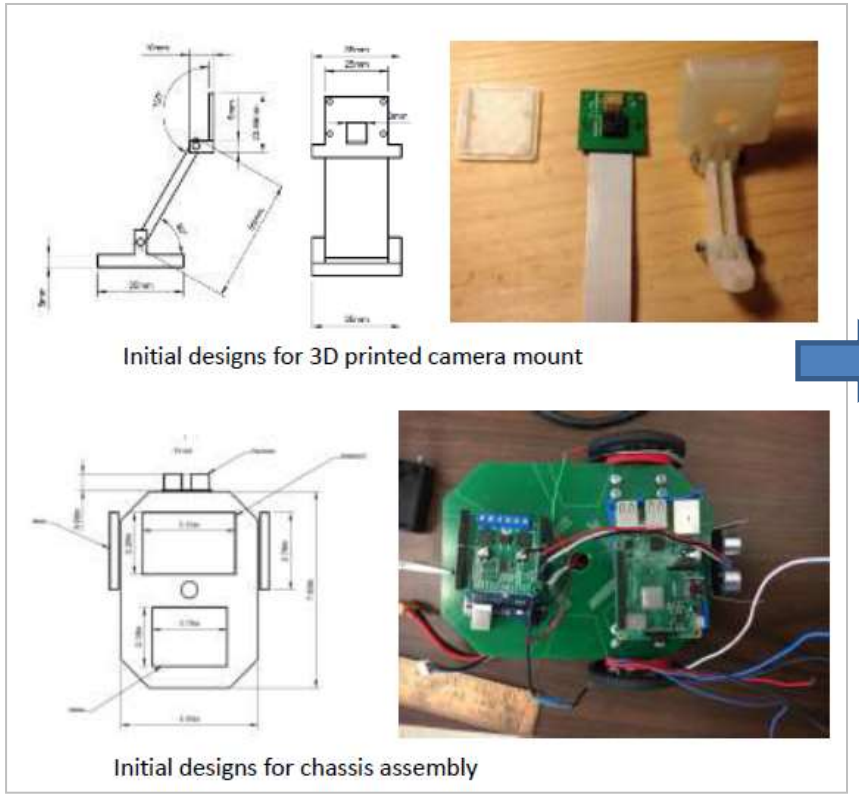
04
AUTONOMOUS BOT

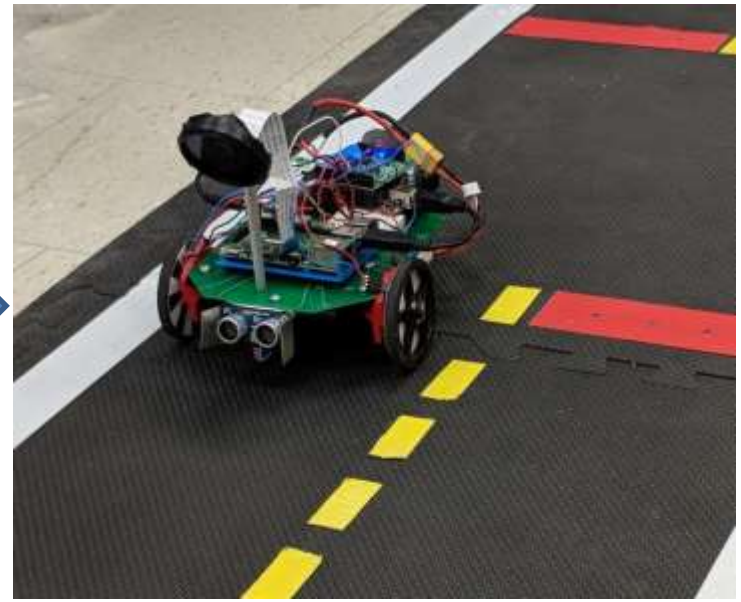
SEP 2018 – DEC 2018
Embedded Systems Lab

This project was a part of the Embedded Systems coursework where we programmed an Autonomous bot to navigate through the MIT Duckietown.
Worked with a diverse team of 5 passionate roboticists from Computer Science, Computer Engineering, Electrical and Mechanical Engineering.

Project Summary

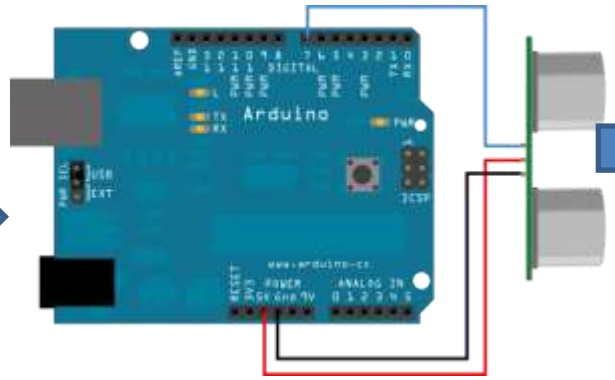
- Designed the bot chassis and mounts for sensors
- Interfaced sensors with Arduino and Raspberry Pi onboard
- Implemented a steering PD control based on the lane center error and wheel turn difference
- Implemented a PD control for speed based on distance to obstruction detected by ping



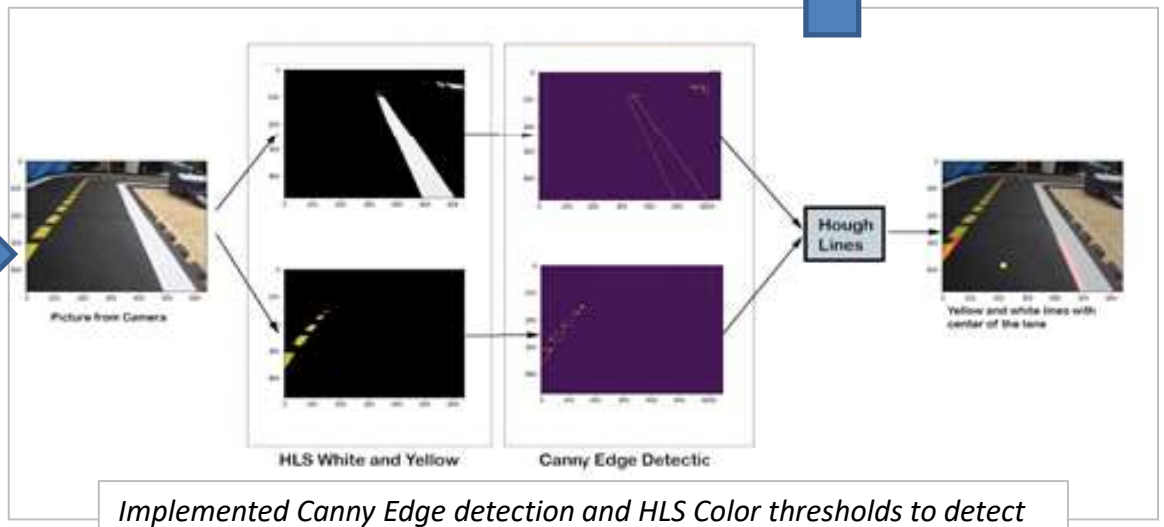


Successfully demonstrated bot on MIT Duckietown setup

Wheel sectors for IR sensors to detect turns



PING Sensor for Obstruction Detection (image for representation)



Implemented Canny Edge detection and HLS Color thresholds to detect lane lines using PiCamera

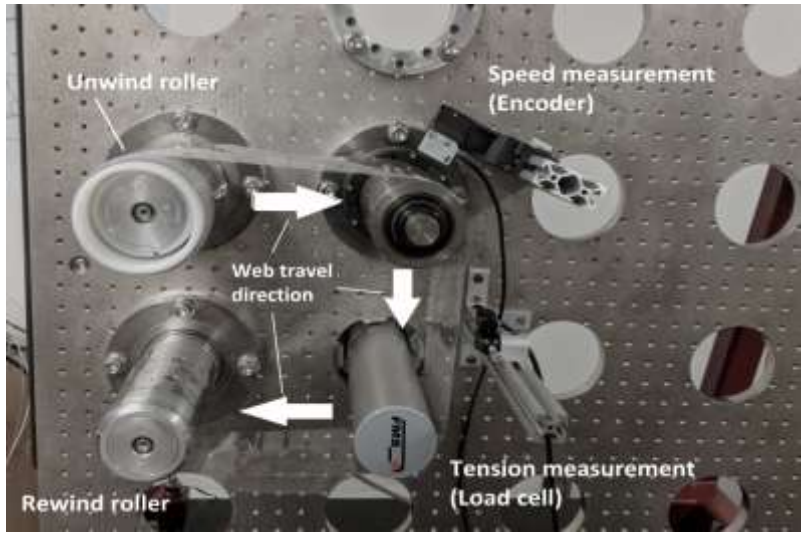
05 SYSTEM IDENTIFICATION

JAN 2019 – DEC 2019
Intelligent Sensing Lab

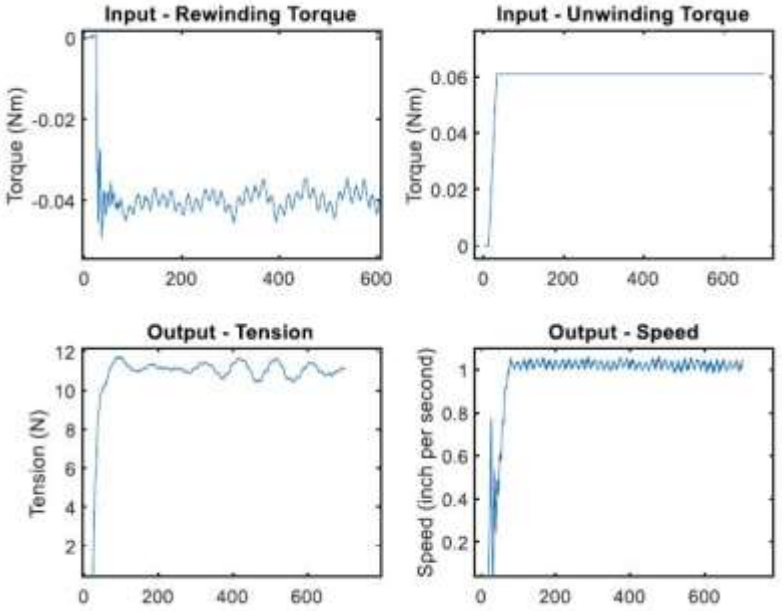
Roll-2-roll printing process is an upcoming technology for mass production of flexible electronics which consists of a stretched flexible substrate traveling over multiple rollers. Precise control of the web (substrate) speed and tension is critical to ensure print quality.

Project Summary

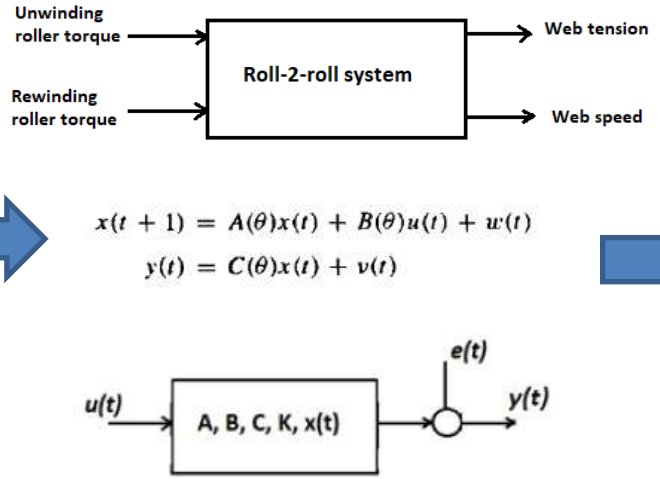
- Procured and installed sensors required for appropriately measuring the web tension, speed and vibration
- Preprocessed sensor data from micron-scale roll-to-roll printing of flexible electronics
- Performed system identification of control parameters for predicting the output speed and tension of the substrate
- Computed a black-box model and simulated the tension output with 82% accuracy which enabled implementation of predictive control algorithms



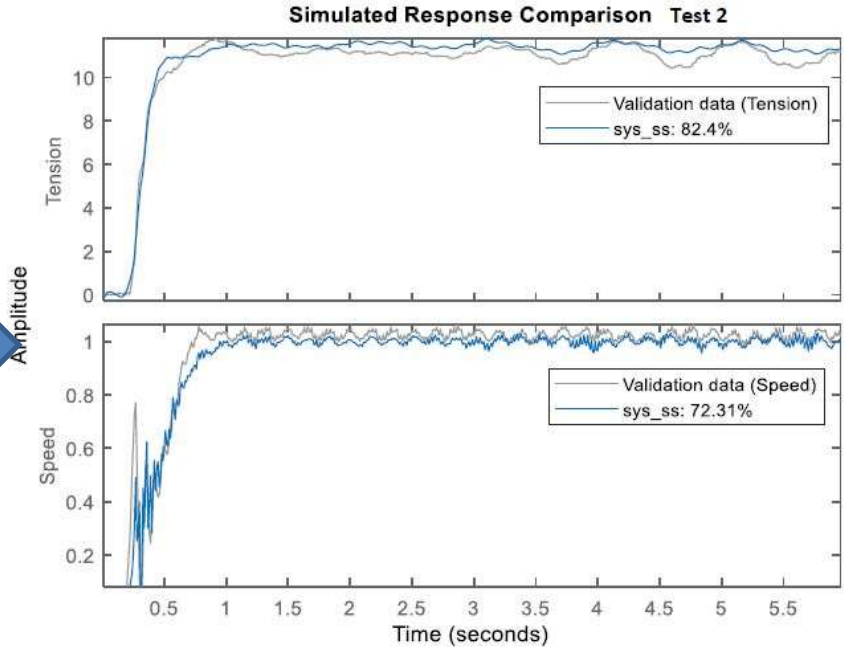
Roll-to-roll printing setup



Used a 2 training inputs (torques) and 2 training outputs (speed, tension)



Used State Space System Identification to identify the order of the system and its parameters



Simulated the outputs by feeding the test input data back to model

06
TOOL FAILURE PREDICTION

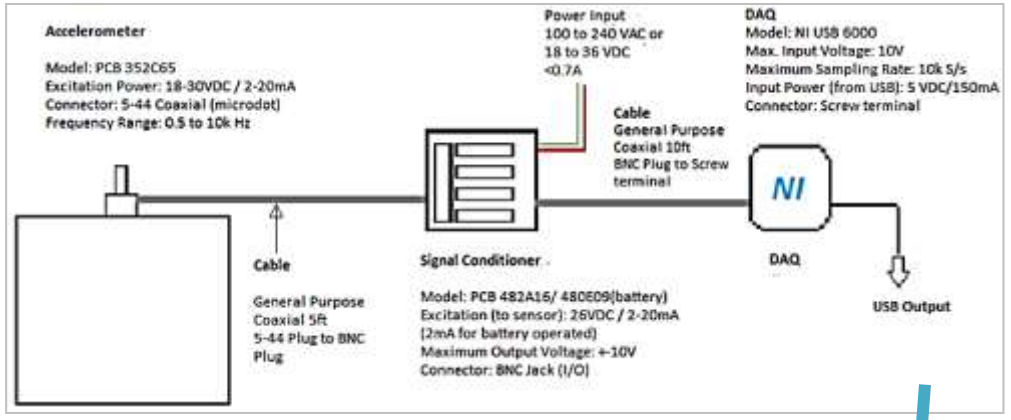
SEP 2018 – DEC 2018
Intelligent Sensing Lab

This project was part of the Intelligent Manufacturing Coursework, where we used machine learning and SPC techniques to identify faults in a manufacturing process

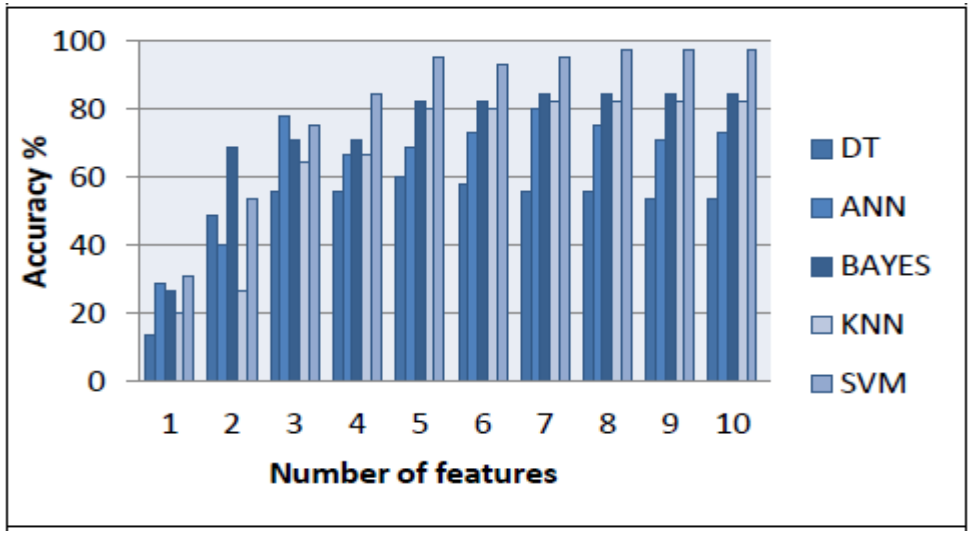
Project Summary

- Performed data acquisition and processing of machine vibration using NI DAQ 6000, Labview and MATLAB
- Procured and setup the equipment for data acquisition and signal conditioning
- Extracted features, filtered them based on correlation with output labels and further condensed them to a few principal components to group together features with similar characteristics
- Attributed the principal components to different tool failure modes using statistical quality control and machine learning which resulted in a 95% failure detection accuracy in test data

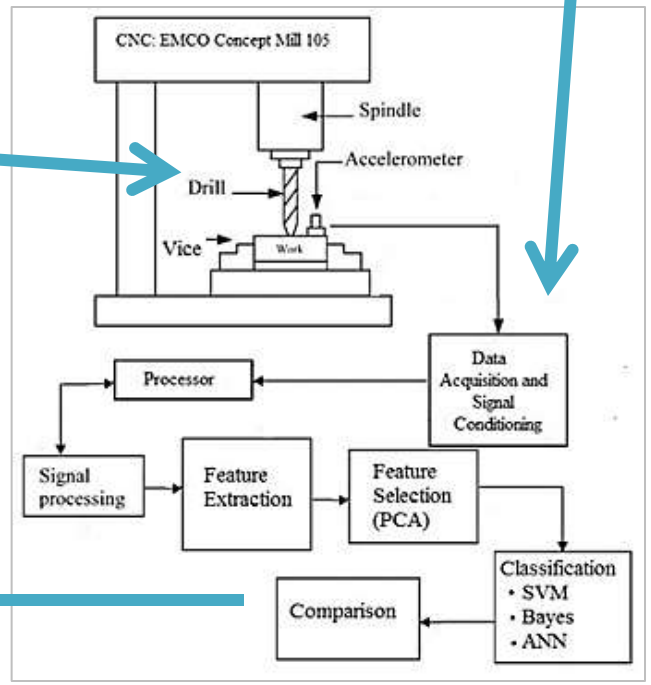
Accelerometer installed on the drilling vice



Data Acquisition and Signal Conditioning setup



Comparison of accuracy of machine learning algorithms. SVM performed the best at 95%.

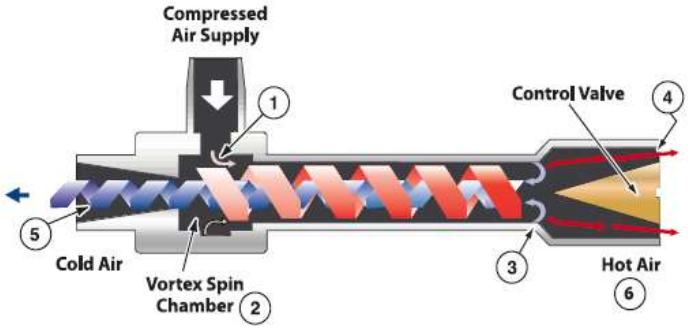


Process Flow Chart

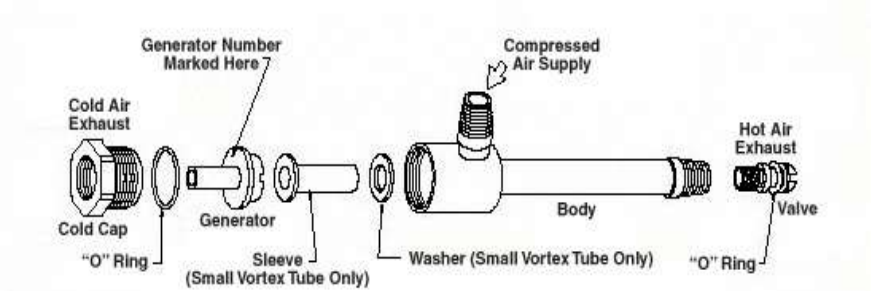
07
VORTEX TUBE ANALYSIS

SEP 2013 – MAY 2014
Undergraduate Capstone Project
1st Position at GeniusX Project Competition

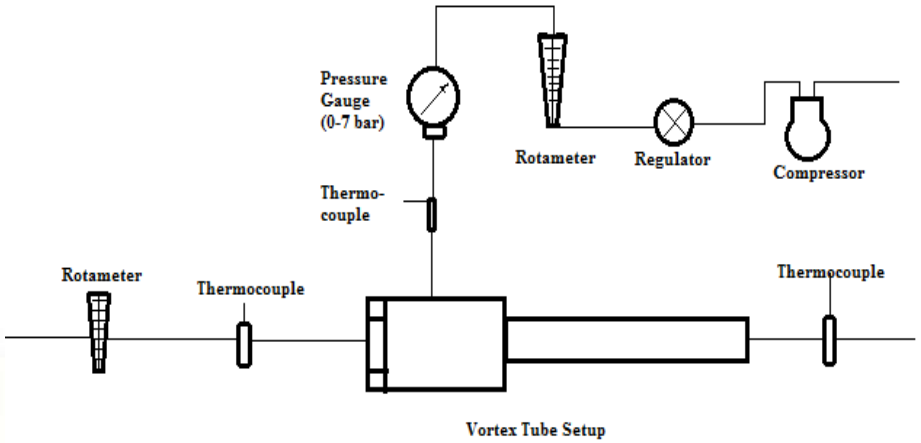
Vortex Tube is a compact device used for spot cooling applications. It has a compressed air input and produces cold air and hot air streams from 2 opposite side of the tube. The temperature drops achieves are higher than a standard throttling expansion and hence it is useful in electronic chip cooling applications



Principle of operation: Temperature Separation



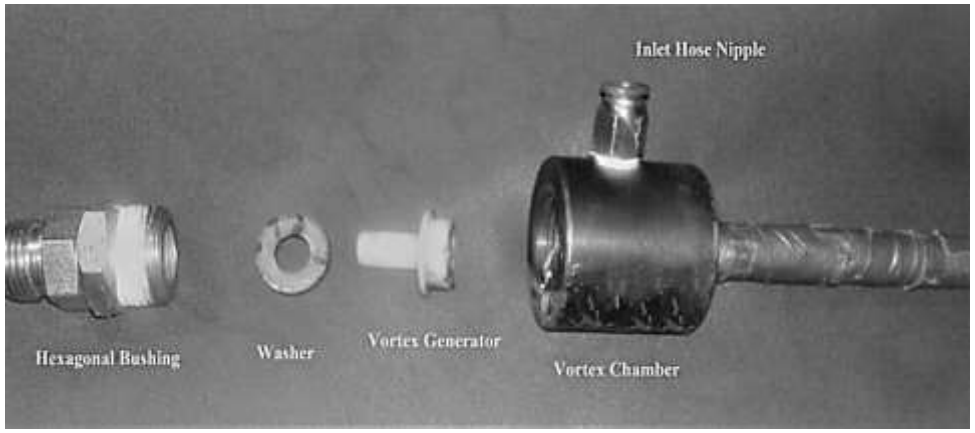
Exploded View of the Vortex tube design



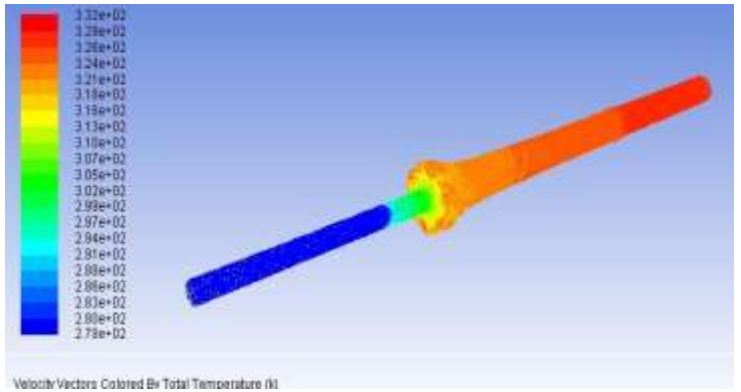
Setup a test rig for acquiring process parameters like temperatures, flow rate, pressure

Project Summary

- Procured standard components and raw material for fabrication
- Fabricated the vortex chamber and hot end valve mechanism
- Had a hands-on experience with a variety of manufacturing techniques like turning, soldering, welding, tapping and other supporting operations
- Procured sensors and setup test rig for acquiring process data
- Performed CFD analysis to study the effect of hot outlet geometry and to optimize the performance of the vortex tube



Exploded View of the fabricated Vortex tube. (Fabricated the Vortex chamber on m/c shop lathe and 3D-printed the vortex generator)



Performed CFD analysis to tune optimization parameters

08
DESIGN OF AUTOMOTIVE COMPONENTS

NOV 2014 – JUN 2017
TAAL Technologies, Bangalore, India

TAAL Technologies is a major engineering services provider with Automotive, Aerospace and Industrial project verticals. The Automotive team is a diverse group of engineers dealing with design of exhaust systems, heat exchangers, seating, BIW etc.

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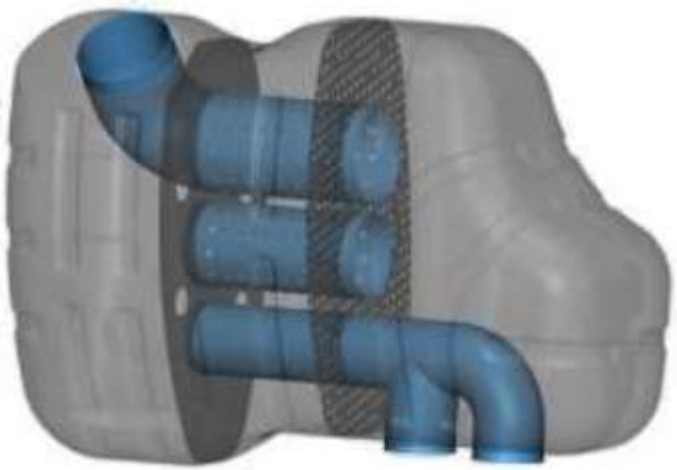
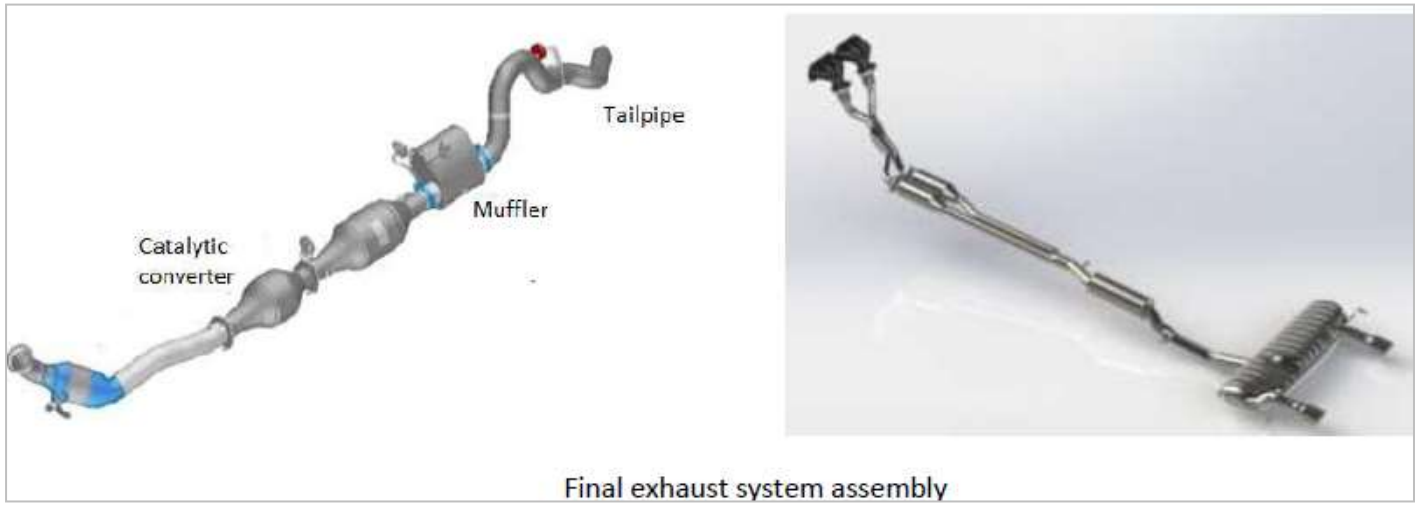
Project Summary

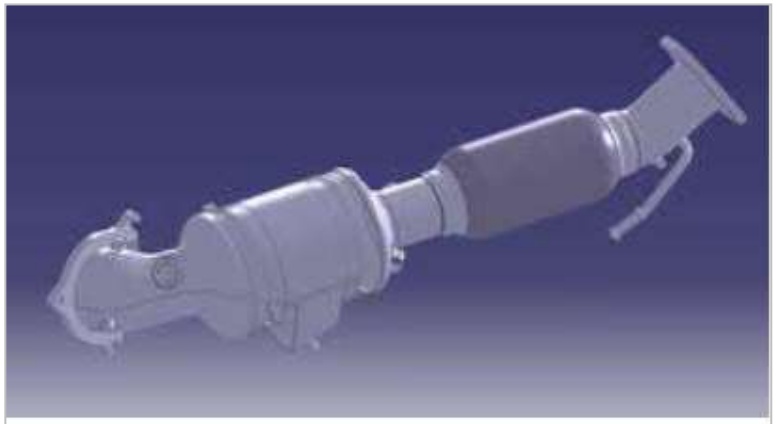
- Designed rear mufflers while accounting for space constraints and draft analysis
- After approval of the outer shell design, I designed prototypes with different pipe routings and perforated plates for acoustic testing by onsite engineers
- Designed the exhaust assembly components and created drawings for final production release
- Led ISO quality process implementation and produced best-practices documentation for knowledge repositories



Rear muffler CAD model (CATIA)



Final exhaust system assembly



Hot end exhaust assembly w/ catalytic converter and resonator (CATIA)

(Due to confidentiality issues, I cannot provide the images of the projects that I executed while on this assignment. Above included some public domain images of the models which exactly resemble the projects that I worked on)