

## Overview

### Goals:

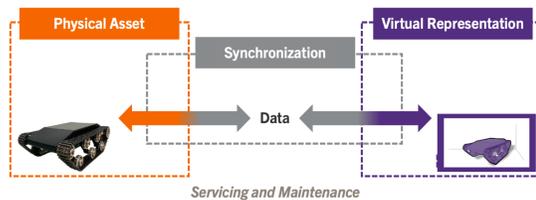
- Developing a digital twin for a tracked robotic vehicle to improve design, testing, and optimization
- Utilizing Siemens NX, Teamcenter, and Google Cloud for real-time data integration and advanced simulations
- Incorporating 3D-printed sensor mounts, Wi-Fi-enabled data transfer, and stress testing to refine the digital twin



Image of physical robot

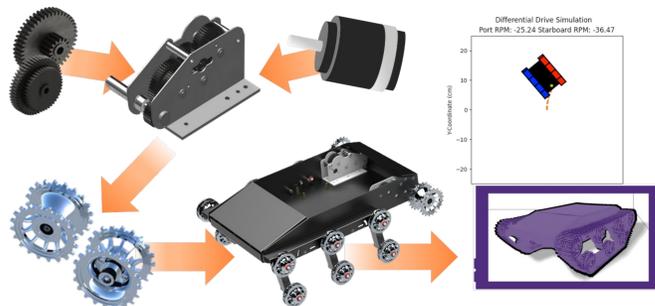
### Digital Twins:

- A digital twin (DT) is a computerized representation of a physical object
- Ranging from a simple static CAD model to a complex system with data integration and active sensors
- Easily modified, scaled, and simulated for various applications



## Application

- Improving PLM processes allows us to optimize and better understand the behavior of real-world systems and their subcomponents



## Sensor Rig

### Goals:

- Assemble a Prusa MK4 3D Printer
- Design and print an ultrasonic sensor rig
- Create a brace for the sensor rig to reduce extreme vibrations

### Developed requirements:

- Position on robot to optimize functionality of the sensor
- Easily detachable from the robot
- Minimal weight and material for production efficiency and vehicle performance
- Simplicity of wire management
- Works in synergy with other rig components for future sensors



Assembled sensor rig

## Integrating Sensors

### Goal:

- Develop a system to send real-time sensor data over Wi-Fi to Siemens Teamcenter via Google Cloud for fast data transfer and easy access

### Activities:

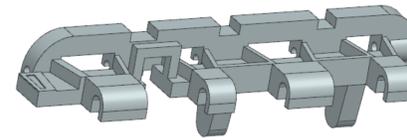
- Wrote and tested a program to send data from the accelerometers, temperature sensors, and ultrasonic rangefinders using HTTPS for easy integration with Siemens Teamcenter
- Configured Google Cloud to receive and store the data before forwarding it to Teamcenter
- Automated data transfer using Google Cloud Storage API, Cloud Functions, and a JavaScript function to upload sensor data from Google Cloud to Teamcenter

## Projects

### Track Design

### Goal:

- Design tracks for the Digital twin and model the part and assemblies in NX



NX part model of track segment

### Track Simulation

### Goal:

- Gain insight into several factors that act on the track assembly, including friction, forces from objects, torque, inertia, etc.

### Simulation Research

- Considered equations and analysis techniques based on previous research outlines
- Completed training on torques simulations in NX

### Activities

- Modeled track vs. Ground interaction in NX Siemens, applying material bounds, vehicle forces, and friction coefficients gathered from research

## Motor Characterization and Efficiency

### Goal:

- Determine the maximum load that the robot can carry before reaching stall torque in order to determine maximum load for additional annexes to the robot

### Activities

- Determine the type of motor for specifications needed for dynamic modeling
- Determine how to run tests to determine max load

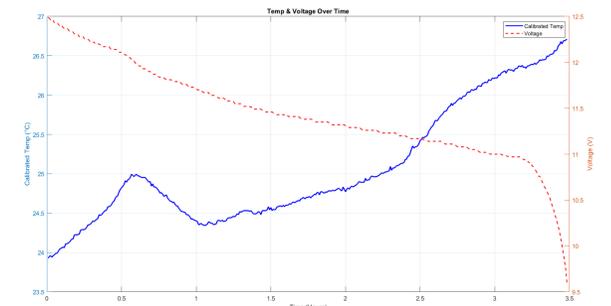
## Battery Optimization

### Goal:

- Create an accurate battery model to estimate the charge of the battery by measuring/estimating battery characteristics in real time
- A battery model enables us to predict the battery's behavior under specific conditions without needing to test the actual battery

### Activities:

- Conducted experiments to test the battery under various conditions
- Integrated the experimental data into the model to compare it with theoretical predictions



Battery discharge curve of LiPo 3S battery at 0.4 amps

## Fatigue Analysis

### Goal:

- Simulate the fatigue life of the suspension system of the vehicle under different loads

### Activities

- Used NX to model the suspension spring component
- Created an assembly of the needed parts from the suspension system
- Ran stress and durability analyses



Spring Assembly



Fatigue simulation

The Product Lifecycle Management Center (PLMC) promotes PLM tools and processes that support the growing movement for corporate digitalization. The PLMC also provides access and training for a variety of PLM applications. Learn more about the PLMC here by following the QR code at right.

