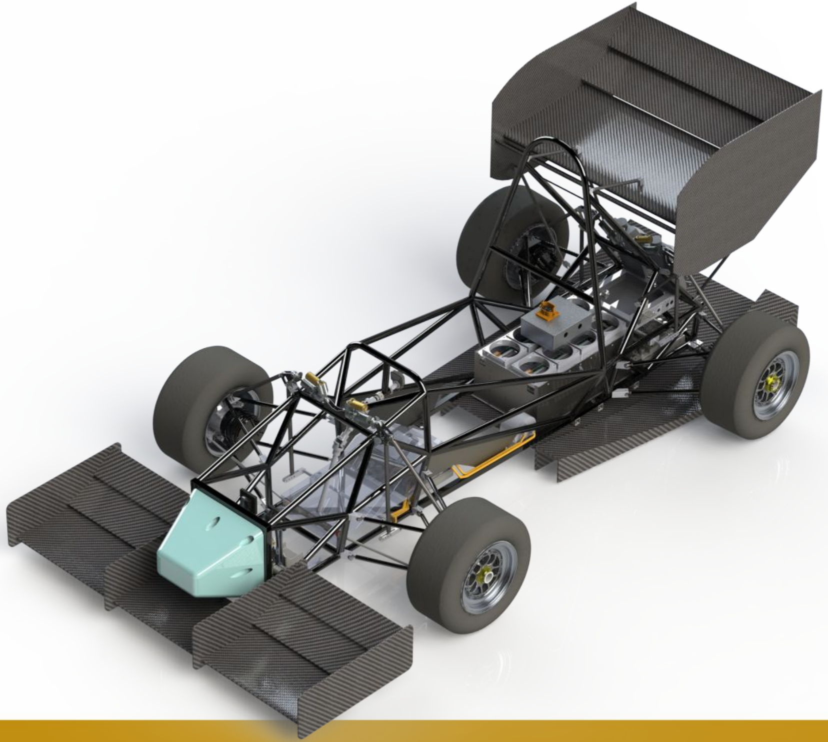
Torque Vectoring Transition

Purdue Electric Racing ‘22 Controls System



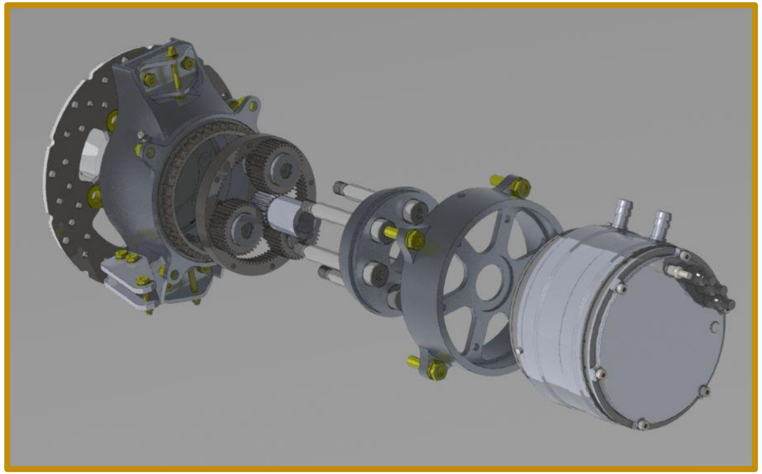
PURDUE ELECTRIC RACING

Desired Meeting Outcomes

- Provide vital information sources to facilitate transition
- Outline key components of the simulink model
- Outline discrepancies between simulink model and intended implementation

Motivation

To develop a control scheme for a 4WD hub motor system in Matlab/Simulink to be implemented and validated on PER '22.



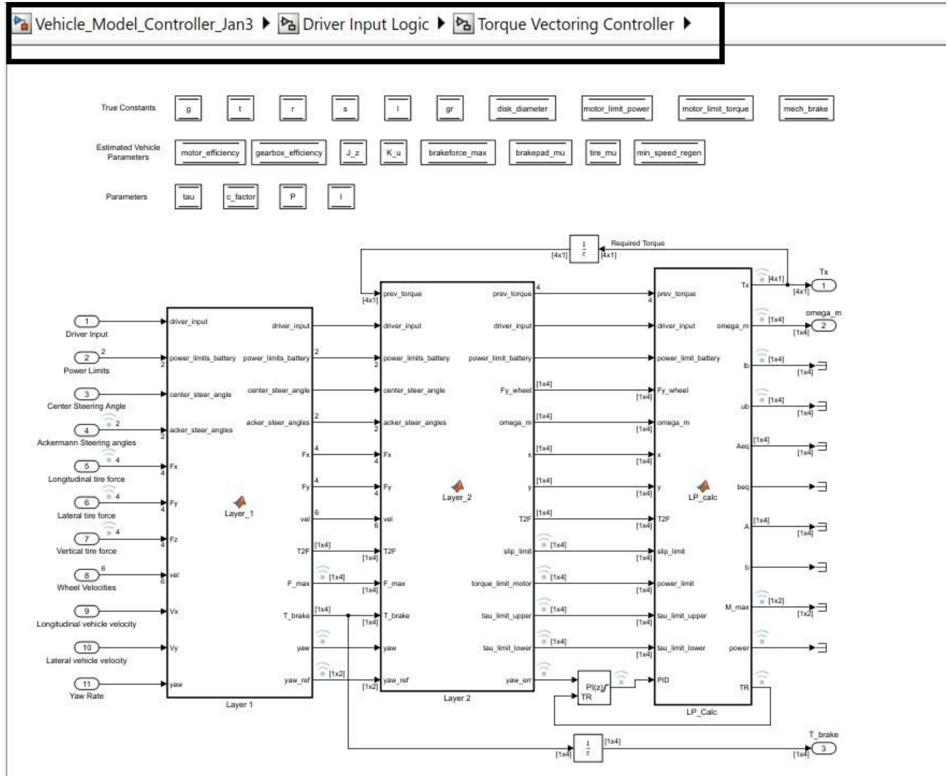
Information Sources

- Basic Documentation is within Simulink MATLAB blocks itself
- Additional Documentation found on GitHub (incomplete, LP Variables Menu)
- Lot of reference documentation (theory, Simulink) can be provided as necessary

Information Links

- Model GitHub Page
- Optimization Function MATLAB Documentation
- PI Controller Theory
- Torque Vectoring Theory

Relevant Sections



- 3 MATLAB Function Blocks
  - Optimization function
  - Sine & Cosine
  - Lots of vectors
  - Lots of constants
- PI Controller

Development - Discrepancies

- Variables T2F, e_term, c_lower & c_upper are constant during runtime. They are dependent on other constants that may change.
- Convert acker_steer_angles, Fx, Fy, Fz into mathematical model
- Possibly compute Fx_max using a better friction circle

Suggestion

- Suggested Order
  - LP_calc
  - PI Controller
  - Layer 2
  - Layer 1
  - Layer 0

Development - Optimization Statement

Objective:

- Maximize total driving force

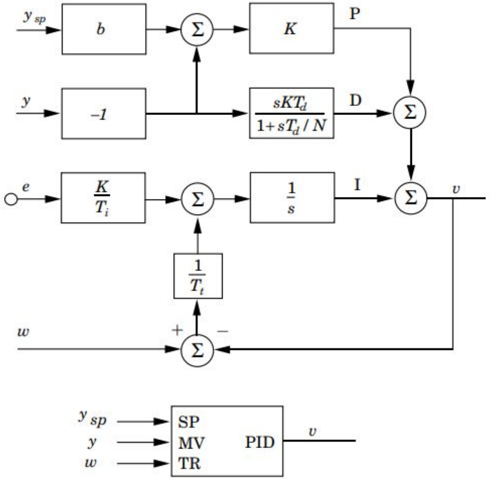
Subject to:

- Total power input must not exceed total power available
- Vehicle yaw acceleration must be equal to PID
- Torque per motor must stay between an upper and lower bounds, based on slip, power, and motor defined limits.

- Objective Function
- 1 linear equality
- 1 linear inequality
- 4 boundary constraints (lower and upper) corresponding to 4 torques

Development - PID

- PI Controller, with fixed proportional and integral gains
- Controls the yaw rate based on reference, $\dot{\varphi}_{ref}$
- Error: $e = \dot{\varphi}_{ref} - \dot{\varphi}_{real}$
- Output: Yaw moment, $\propto \ddot{\varphi}$



PI Controller Theory, pg 231