Code Brainstorming and Equations

Tuesday, February 11, 2025 4:43 PM

Steering Forces -> Using a current Steering force calculator as reference

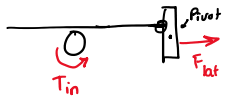
Calculate required Self aligning torque -> Steering Output torque must be greater

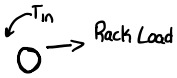
Input
- pnomatic trail
- Mechanical trail
- Scrub radius
- Torque Arm
- Normal force on tires
- Max aligning torque
- Friction Coefficient
- Lat force

Input best Steering torque

Calculates required pin gear diameter

Going to require more insight





We now need to find the necessary diameter and ratio to meet this self aligning torque

We want a force per hand lower than 20lb
-> The program can loop through

Compared to the Spreadsheet, I'm adding a gear selection matrix that will allow comparisons between different gear ratios, all in one spot

Calculating Tyre Load and Self aligning torque

$T_{SA} = x_{TA} \cdot F_{Lat} + T_{SA}$

$x_{TA} = \sqrt{r_S^2 + (T_P + T_M)^2}$ => Torque Arm: Given by geometry

$F_{Lat} = F_N \cdot \mu_S$ => Lateral force on tyres

r_S => Scrub Radius, defined by suspension geometry

T_P & T_M => pnumatic and mechanical trail, defined by geometry and tyre data

F_N & μ_S => Found based on previous running data

T_{SA} => Self aligning torque, known from tyre data

With this, we can calculate the self aligning torque present on the steering system

Calculating the steering torque output, based on a known input force

$T_{S_o} = F_R \cdot L_{SA}$ => T_{S_o} - Steering torque output - Calc
F_R - Force on the linear rack - Calc
L_{SA} - Steering arm Length (Given)

$F_R = T_{S_i} / (D_G/2)$ T_{S_i} - Steering Torque Input - Calc
D_G - Diameter of the gear - Variable

$T_{S_i} = R_W \cdot F_i$ F_i - Input force (Both hands) - Given
R_W - Radius of steering wheel - Given

Linear Rack Travel

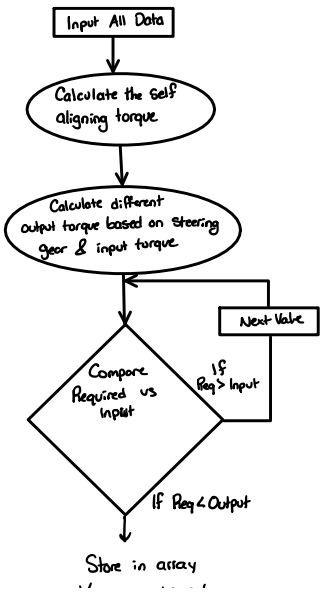
Pinion Gear	Cfactor	Steering Ratio
0.938	2.946813	6.452
1	3.14159	5.716
1.125	3.53429	5.154
1.25	3.92699	4.562
1.375	4.319689	3.9526
1.5	?	3.9526
1.625	5.10508	3.3414
1.75	5.49778	2.7302

Linear Rack Travel = $\frac{\text{Wheel Input Required for Steering}}{360} \left(\text{Pinion Gear Diameter}\right)\pi$

Wheel Input Required = Steering Ratio · 69

Flow Chart:

Steering Force Calculations



Pseudo Code:

Store Data:

$F_{Lat} = F_N \cdot \mu_S$

$x_{TA} = \sqrt{r_S^2 + (T_P + T_M)^2}$

$T_{SA} = x_{TA} \cdot F_{Lat} + T_{SA}$

Load Spreadsheet data containing Steering force and gear data → Data: Force, Diameter, Teeth

Calculate forces and store in new array

Create empty array

for F in 1:size(data(-))

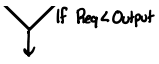
for D in 1:size(data(-1))

$T_{S_i} = R_W \cdot F_i$

$F_R = T_{S_i} / (D_G/2)$

$T_{S_o} = F_R \cdot L_{SA}$

data.append(T_{S_o}) ← Whatever the



Store in array
w/ gear and input
data

$\cdot (V_0/2)$

$T_{50} = F_R \cdot L_{SA}$

data.append(T_{50}) ← Whatever the syntax is Matlab is easier for arrays