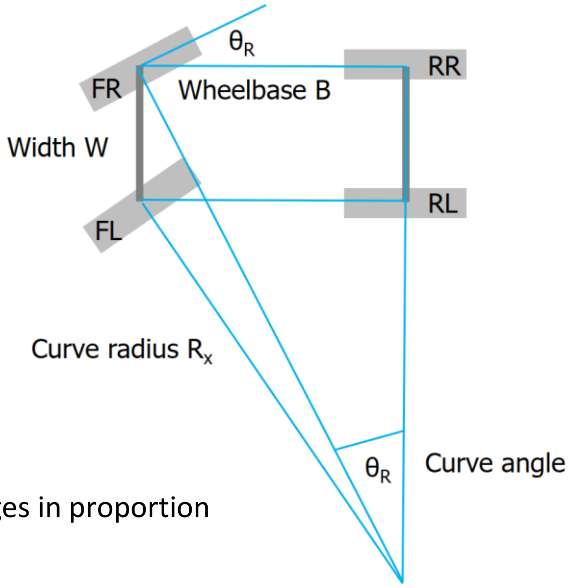
Tire Pressure Monitoring

DHBW Automotive Software Engineering – Stuttgart, © Kai Pinnow 2019

1. Introduction and Overview

The project work focuses on tire pressure monitoring. Detailed requirements below.

As depicted, the following equations govern the motion for a left turn:



(1) $R_{RR} = W + R_{RL}$

(2) $R_{FR}^2 = B^2 + R_{RR}^2$

(3) $R_{FL}^2 = B^2 + R_{RL}^2$

(4) $B = R_{RR} \tan \theta_R$

(5) $B = R_{RL} \tan \theta_L$

Please note that any pair of velocities changes in proportion to the related curve radiuses

(6) $V_x / V_y = R_x / R_y$ for any x,y from {RR, RL, FR, FL}

A drop in tire pressure of a single wheel results in an increase of the respective velocity of that wheel since it will be a little smaller then.

2. Requirements and Deliverables

Please refer to “ID“ column in your documentation. A * denotes extra tasks / requirements.

ID	Check
R1	A tire pressure monitor allows observation of the four wheel speeds to detect an unexpected imbalance for a vehicle with sizes B=1.53 m and W=2.65 m.
R2	An imbalance of a wheel speed of 0.5 % of one of the wheels concerning the expected consistent wheel speeds will be regarded as an indication of a tire pressure drop.
R3	Detecting a tire pressure drop, some warning lamp shall be switched on and some “SOS” (three times short, three times long, three times short) sound shall appear (base rate 0.8 seconds).
R4*	The system shall allow “re-calibration” after inflation.
R5	Design the solution mainly with appropriate graphical modeling elements (i.e. block diagrams and/or state machines) or with scripts or ESDL and document all your decisions, reasoning, and results clearly with screenshots and text.

D1	Plan all necessary tasks based on three point estimates and monitor progress according to below requirements.
D2	Use the provided example data “curve.mat” to calculate, display, and analyze curve radiuses for selected situations. It contains the wheel speeds (vfl, vfr, vrl, vrr) in [km/h] and the steering wheel signal sw (without direction) in [degree] with time base tv in [s], plus the corresponding lateral acceleration q in [g] (with different time base tq again in [s]).
D3	Create a Simulink model that calculates the driving distance for each wheel and analyze the provided “curve.mat” data in this regard. Remember to analyze and document settings. Are there imbalances according to requirement R2?
D4	Set-up a simple tire pressure monitor in Simulink that detects a deviation according to requirement R1 and R2 by observing driving distances of the individual wheels for straight driving i.e. driving without curves.
D5	Code, configure, and apply a simple “linear congruential” random number generator like `X(i) = (a * X(i-1) + c) mod m` with suitable parameters `a`, `c`, and `m` to test the tire pressure monitoring without the provided “curve.mat” data.
D6	Execute some system tests in Simulink with the number generator from D6 to check the tire pressure monitoring function feasibility.
D7	Transfer the tire pressure monitoring function to ASCET.
D8	Provide unit tests for all designed tire pressure monitoring components.
D9	Design a warning function according to requirement R3.
D10	Provide the random number generator designed in D5 in ASCET with unit tests.
D11	Create a system test with the aid of the number generator and some error model i.e. simulating some pressure drop over a certain time to demonstrate the tire pressure monitoring.
D12*	Think about the way to calibrate the system by means of requirement R4. Which parts of the implementation shall change in order to support such a feature? How long does one need to drive for calibration?
D13*	Shall the analysis incorporate curve driving or just analyze segments driving straight?
D14*	Reflect: Which other observations or comments are in place concerning the model, the requirements, the prescribed functions, or your solution, the testing, and the selected graphical approach.