PROTECTION OF THE SIDESHAFT VIRTUAL DAMPING CONTROLLER

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Recommended Citation
Blunder, Verena, "PROTECTION OF THE SIDESHAFT VIRTUAL DAMPING CONTROLLER", Technical Disclosure Commons, (September 01, 2020)
https://www.tdcommons.org/dpubs_series/3569

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PROTECTION OF THE SIDESHAFT VIRTUAL DAMPING CONTROLLER

Initial situation:
Torsion of the sideshaft is not known at runtime and is only measured in development vehicles with special measurement technology. Component protection must be ensured by design and verified by stress tests.

Solution:
The drive train motor to wheel including the sideshaft is modelled and the state variables EM speed, wheel speed, torsion angle and wheel torque are estimated by an observer. By this observer the torsion of the sideshaft can be quantized without any further measuring technique and it can be limited by control.

The control is carried out by a PI state controller, which specifically introduces damping into the drive system.

Advantages:
The torsion of the side wave is known at runtime through the estimation of the observer and can be counteracted by control engineering measures.

Possible application:
The protective function is realized here by two different mechanisms:

Variant1 (blue):
By specifying a torsion setpoint angle or a maximum torsion angle, the speed control is switched from speed control to torsion angle control when a critical torsion is reached. Only the prefilter has to be adapted. This serves to compensate for the zero point of the line. The PI controller and the downstream status controller including parameterization, dynamics and properties can still be used.

Variant 2 (green):
The damping and thus the controller dynamics of the state controller is changed depending on the actual torsion. If the torsion angle rises into critical ranges, the damping is increased. In this case, no changeover of the controlled variable is required.

Since this is a system-internal feedback of a state, the eigenvalues can be shifted if the dynamics are too high when adjusting the damping. Accordingly, the damping should be increased quickly within limits, but reduced with low dynamics.
\[ \mathcal{G}_{Tors}(s) = \frac{\mathcal{E}}{\mathcal{M}} = \frac{Z_{s,Tors}}{N_{ZR}} \]

\[ Q_{Tors} = \frac{1}{Z_{s,Tors}} \]

\[ \mathcal{G}_{Drz} = \frac{\omega}{\mathcal{M}} = \frac{Z_{s,Drz}}{N_{ZR}} \]

\[ Q_{Drz} = \frac{1}{Z_{s,Drz}} \]

\[ D = f(\mathcal{E}_{Tors}) \]