Modelling and Implementing a Slip Target Shaper for Traction Control in F1 Application

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High amplitude oscillations in slip values during corner exit are one of the most important issues to face in traction control design for F1 car. Indeed relevant slip snap overshoots may result in a temporary loss of car stability for the driver, reducing the speed and causing tyres degradation.

After a brief recall of involved vehicle dynamics and traction control aspects, an Input Shaper is presented with the purpose to filter out big changes in slip target seen by PIS controller of the closed-loop system as soon as it gets active, thus trying to mitigate the negative effects of vibrations. Input Shaping background is explained identifying a procedure to provide a shaper form of the command and highlighting its intrinsic robustness through pole-zero analysis. A command generator for the slip target is then discussed throughout all its implementation phases in a RT embedded system: modelling stage within Simulink environment and production of fast-prototyped C code using DSPACE TargetLink toolbox. C modules are ready to be encapsulated directly within the software project of Toyota F1 car, whose concepts together with a sketch of electronic control system are briefly outlined.

Slip Shaper improves traction performances significantly as reported from the track during test sessions in Jerez: telemetry acquisitions demonstrates the effectiveness of Shaper as a tool capable of reducing amplitude of oscillations compared to the case with no slip shaping.

Finally a method, based on Genetic Algorithm, to tune automatically Shaper's parameters for a plant with a known dynamics is described and analysed as a more advanced topic.