Quantification of Road Vehicle Handling Quality Using a Compensatory Steering Controller

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Description of Underlying Data Provided in the Repository

Two data files are provided:

OSresults.mat (oversteer vehicle)
USresults.mat (understeer vehicle)

Files with a .mat extension contain MATLAB formatted data. Use the 'load' function in Matlab to put the contents of the file into the Matlab workspace.

The files contain the data underlying Figures 3, 4, 5, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18.

Each file contains the following data (single variable unless otherwise stated) (SI units):

Ad	9x9x650	state matrix of linearised vehicle at each step (eqn 28)
Bd	9x5x650	input matrix of linearised vehicle at each step (columns are effectively Bk, Hk and Fk from eqn 28)
K	5x9x650	compensatory controller gain matrix (eqn 32)
X	650x1	global x coordinate of centre of mass on optimal trajectory at each step (fig 3)
Y	650x1	global y coordinate of centre of mass on optimal trajectory at each step (fig 3)
controllabillityderivatives	2x650 See Fig 16	
forces	650x4	lateral and longitudinal forces at front and rear tyres at each step
s	650x1	distance along the nominal trajectory of the centre of mass at each step
stabilityderivatives	2x650 See Fig 15	
t	650x1	time at each step
u	5x650	compensatory control input vector at each step (first two inputs as eqn 19, u(3) is lateral force at mass centre, u(4) is yaw moment at mass centre, u(5)=1 for the linearised tyre force)
var_u	5x5x650	covariance matrix of inputs at each step (eqn 40)
var_x	9x9x650	covariance matrix of states at each step (eqn 38)
x	9x650	state vector at each step (first eight states are as eqn 18, ninth state is lateral velocity wrt to the nominal heading, as discussed in section 4 after eqn 27.)
param.control.T0		discrete time step
param.control.Np		prediction horizon length for optimal trajectory calculation(number of steps)
param.control.Nu		control horizon length for optimal trajectory calculation(number of steps)
param.control.q1		cost function weight for optimal trajectory calculation
param.control.Ri	1x2	cost function weight for optimal trajectory calculation
param.dist.delta		std dev of steering angle disturbance (eqn 29)
param.dist.F		std dev of lateral force disturbance (eqn 29)
param.dist.M		std dev of yaw moment disturbance (eqn 29)
param.lqr.Q	9x9	compensatory controller cost function weighting matrix
param.lqr.R	2x2	compensatory controller cost function weighting matrix
param.lqr.N	9x2	compensatory controller cost function weighting matrix
param.car.g		gravitational constant
param.car.rho		density of air
param.car.M		vehicle mass
param.car.Iz		vehicle yaw moment of inertia
param.car.If		front wheel moment of inertia
param.car.Ir		rear wheel moment of inertia

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param.car.a             front wheel distance from centre of mass
param.car.b             rear wheel distance from centre of mass
param.car.rf            front wheel rolling radius
param.car.rr            rear wheel rolling radius
param.car.Gsw           steering gear ratio
param.car.w             half vehicle track width
param.car.bf            proportion of braking torque on front wheel
param.car.br            1-param.car.bf
param.car.ab            proportion of aero downforce on front wheel
param.car.Ax            front cross-sectional area
param.car.Cx            drag coefficient
param.car.Cz            lift coefficient
param.car.U0            initial vehicle speed

param.tyres.C           tyre model parameter
param.tyres.B           tyre model parameter
param.tyres.D           tyre model parameter
param.tyres.E           tyre model parameter
param.tyres.c1          tyre model parameter
param.tyres.c2          tyre model parameter

param.nms.zetan         neuromuscular system damping ratio
param.nms.omegan        neuromuscular system natural frequency

param.sim.roadi         parameters for the optimal trajectory calculation
param.sim.roadint 1x2   (see section 3)
param.sim.roadw
param.sim.intpos 1x2
param.sim.z
param.sim.dcom_hatbound
param.sim.ddcom_hatbound
param.sim.utorque_hatbound
param.sim.ltorque_hatbound
param.sim.dtorque_hatbound
param.sim.dtorque_traj_hatbound
param.sim.ddcom_traj_hatbound
param.sim.sublimit
param.sim.road.xroad 15001x1        specification of road geometry
param.sim.road.yroad 15001x1
param.sim.road.sroad 15001x1
param.sim.road.angroad 15001x1
param.sim.road.xroadl 15001x1
param.sim.road.yroadl 15001x1
param.sim.road.xroadr 15001x1
param.sim.road.yroadr 15001x1
param.sim.road.roadw
param.sim.road.roadi
param.sim.road.roadint 1x2
param.sim.road.dsroad 15001x1
param.sim.road.dangroad 15001x1
param.sim.road.rroad 15001x1
param.sim.linvehicle
param.sim.findoptimal
param.sim.loopref

results.X 650x14        results of optimal trajectory calculation (section 3)
results.ddcom 650x1
results.dtorque 650x1
results.t 650x1
results.xpos 650x1
results.ypos 650x1
results.Fzf 650x1
results.kf 650x1
results.af 650x1
results.Fyf 650x1
results.Fxf 650x1
results.Fzr 650x1
results.kr 650x1
results.ar 650x1
results.Fyr 650x1
results.Fxr 650x1
results.A 14x14x650
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results.B 14x2x650
results.F 14x1x650
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