A SELF TUNING CONTROLLER FOR A SWITCHABLE DAMPER SUSPENSION

A. M. A. Soliman[1] *and D. A. Crolla*[2]

[1]*Minia University, Egypt, E-Mail arefmsoliman@yahoo.com*
[2]*The University of Leeds, UK, E-Mail D.A.Crolla@leeds.ac.uk*

Abstract

In vehicle suspension design, an adaptive system is intended to deal with slow dynamic changes corresponding to changes in road input conditions. However, the adaptation to the variation of vehicle parameters is an important consideration in the switchable damper. This paper represents a self-tuning control algorithm for vehicle suspension design. The controller provides the set of gains over different operating conditions, and is based on the adapted estimates of vehicle parameters and states, and the adapted weighting parameters. A quarter car model for the switchable damper suspension system is used. The effect of extreme cases with a fixed gain controller for the switchable damper suspension system is investigated. The proposed self-tuning system was used to control the switchable damper suspension system. The results showed that the switchable damper with self-tuning gives a significant improvement over fixed gains and passive suspension system.

Nomenclature

A(t)	Differential equation coeff. matrix	C	Measurement state matrix, Ns/m
$C_1..C_3$	Switchable damper settings, Ns/m	C_d	Demand damping parameter, Ns/m
C_s, C_t	Susp. and tyre damping coeff., Ns/m	C_a	Actual damping parameter, Ns/m
F(t)	Differential equation coeff. Matrix	F_d	Switchable damper control force, N
f_0	Low cut-off frequency, Hz	G_0	Coefficient with a value of 1, $m^{-2}s^{-1}$
G	Road roughness coeff., m^3 / cycle	K(t)	Control gain matrix
K_s, K_t	Suspension and tyre stiffness, N/m	L(t)	Optimal observer gain matrix
M_b, M_w	Body and wheel mass, kg	P(t)	The solution of the Kalman filter
n	Slope of road input		Ricatti equation
q_1, q_2	Relative weighting parameters	T_c	Time constant, sec
U(t)	Control force, N	V(t)	Measure. noise intensities matrix
V_1	Vehicle forward speed, m/sec	W	White noise input matrix
w(t)	Zero-mean Gaussian white noise.	Z_b, Z_w	Body and wheel mass displ., m with intensity 1.
		Z	State variables
v(t)	Measurement white noise with the	Z	Ground input displacement, m intensity matrix of V(t)