Optimal and Robust Control of Active Suspension System for a Quarter Car Model

Zineb Boulaaras[1*], Abdelaziz Aouiche[1], Kheiredinne Chafaa[2]

[1]LABGET Laboratory, Department of Electrical Engineering Faculty of Science and Technology, Echahid Cheikh Larbi Tebessi University Tebessa 12000, Algeria

[2]LAAAS Laboratory, Department of Electronics faculty of Tchnology, University of Batna 2, Batna 5000, Batna, Algeria

*Corresponding author's e-mail: Zineb.boulaaras@univ-tebessa.dz

ABSTRACT

The vehicle's comfort and stability while driving is significantly influenced by the suspension. An active suspension system is utilized in place of the conventional mechanical suspension system (passive suspension system) to enhance safety in addition to comfort and convenience. The suspension system is classified as a three types passive, semi active, and active suspension. The PID controller, LQG controller, FOPID controller, and other control devices, are utilized to regulate the active suspension system. The application of the quadratic linear regulator (LQR) controller for active suspension is the main topic of this study. According to research findings, active suspension systems considerably increase the displacement values and inflated block acceleration of a vehicle. In this work the authors focus on control an active suspension system by LQR control, and comparative the results with passive suspension. LQR controller support body movement optimization, particularly given how noisy the road is. Future, more sophisticated research will be supported based on the findings from this study.

Keywords: Active Suspension, Passive Suspension, LQR control.

1 Introduction

The soft connection between the wheel and the body is the vehicle's suspension system. Road surface vibration can be controlled and quenched by the suppression system. In addition, the vehicle's stability is supported by the suspension system when turning or steering [1].

The objective of this research is to create a good suspension system, several performance factors must be to feen into a car, where These traits have to do with force distribution suspension movement regulation, and body movement regulation [2].

The primary focus of this abstract comparison of passive and active suspensions will be on improving ride quality. The LQR control system is selected to regulate an actuator in active suspension. The results show how an active suspension can improve ride quality.

2 Methodology

The quarter-vehicle system has two degrees (show Figure 1) of freedom and consists of two bodies: the spring-loaded block for the vehicle and the unsprung block for the suspension, wheels, and tires. Although it is a simplified model, system stiffness and damping are used to avoid everything being considered rigid (which a physical model is not). As a result, the stiffness and damping of the tire and wheel between the road and suspension are taken, as well as the stiffness and damping of the spring and damper between the suspension and the vehicle [3].

Where: Ks, Kt is Spring of suspension system, and Spring of wheel and tire, Cs, Ct is Damper of suspension and wheel, Xs, Xu, and Xr is Body Displacement, wheel displacement, and Vertical position of the road profile.

The describing the oscillation of the vehicle are shown in equation 01:

DOI: 10.21467/abstracts.163 ISBN: 978-81-965621-5-1 (eBook)

$$\begin{cases} M_s\ddot{X}_s = -K_s(X_s - X_u) - C_s(\dot{X}_s - \dot{X}_u) + F \\ M_u\ddot{X}_u = K_s(X_s - X_u) + C_s(\dot{X}_s - \dot{X}_u) - K_t(X_u - X_r) \\ \qquad -C_s(\dot{X}_u - \dot{X}_r) \end{cases} \quad (1)$$

The equation (2) shows the model of a quarter car defined in a state space format [5]:

$$\begin{cases} \dot{X} = AX + BF + HX_r \\ Y = CX + DF + GX_r \end{cases} \quad (2)$$

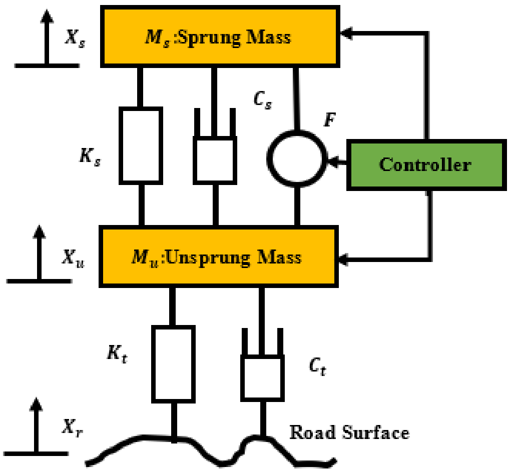

Figure 1: *Active suspension system of Quarter Car Model [4]*

3 Results and Discussion

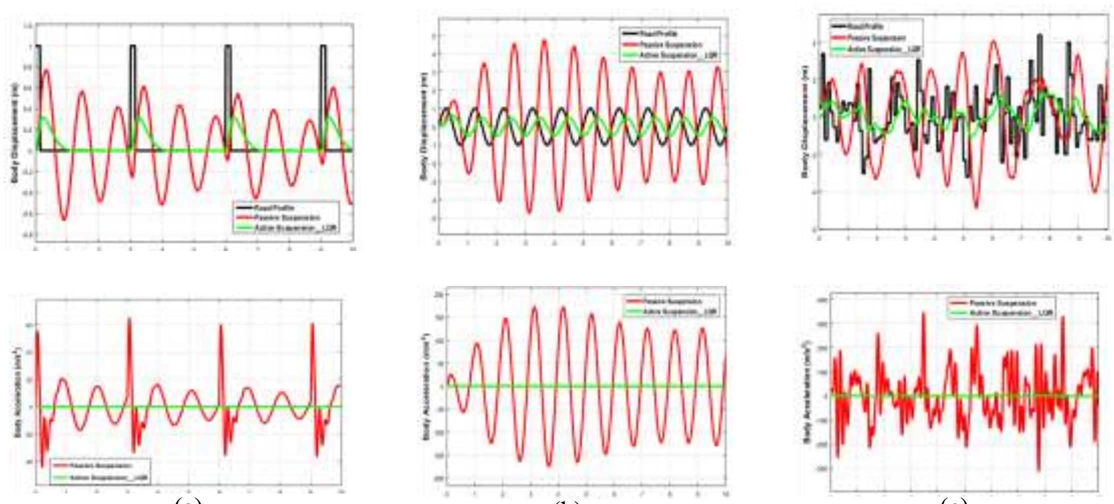

Figure 2: *Body Displacement and Body Acceleration of passive and active suspension with (a) Variable-step Road Input, (b) Sinusoidal Road Input, and (c) Random Road Input.*

The MATLAB program is used to carry out the simulation task. The simulation is performed using the sinusoidal input signal and the random input signal with variable-step signal, respectively, taking into account that the automobile has moved down a bumpy road. The figures follow show the simulation results for both test signal and it focus of body displacement, body acceleration (see Figure 2). As a consequence of the simulation, active suspension with the LQR controller can be seen as one of the solutions for modern cars' exceptional comfort rides and good handling.

ISBN: 978-81-965621-5-1
Series: AIJR Abstracts
DOI: 10.21467/abstracts.163

4 Conclusion

Overall, the comfort and stability of the vehicle can be greatly increased when it has an active suspension system.

How to Cite

Z. Boulaaras, A. Aouiche, K. Chafaa, “Optimal and Robust Control of Active Suspension System for a Quarter Car Model”, *AIJR Abstracts*, pp. 39–41, Feb. 2024.

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ISBN: 978-81-965621-5-1

Series: AIJR Abstracts

DOI: 10.21467/abstracts.163