Maestría en Ingeniería en Automatización de Procesos Industriales

Title

Design and implementation of a controller for a magneto rheological damper of automotive application

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Design and implementation of a controller for a magneto-rheological damper of automotive application

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1. Introduction

The semi-active vehicle suspension systems use magneto-rheological damper which contain magnetizable particles suspended in carrier fluid. These particles are susceptible to the magnetic field that is applied during its operation. Through this, damping factor is regulated[1].

Currently vehicles that use this kind of system are: Lamborghini in its model Huracan, Ferrari in its model 599 GTB, Audi in the model R8, Chevrolet in its models Corvette and Camaro among others [2].

2. Objectives

2.1. General objective

To generate a control proposal for a magneto-rheological damper as an alternative in automotive application using one of the existing control techniques.

2.2. Specific objectives

- To parameterize the model of the magneto-rheological damper using MATLAB-Simulink.
- To simulate, using MATLAB-Simulink, the designed control for magneto-rheological damper.
- To implement the designed control for the magneto-rheological damper on a test bench to measure performance.

3. Method

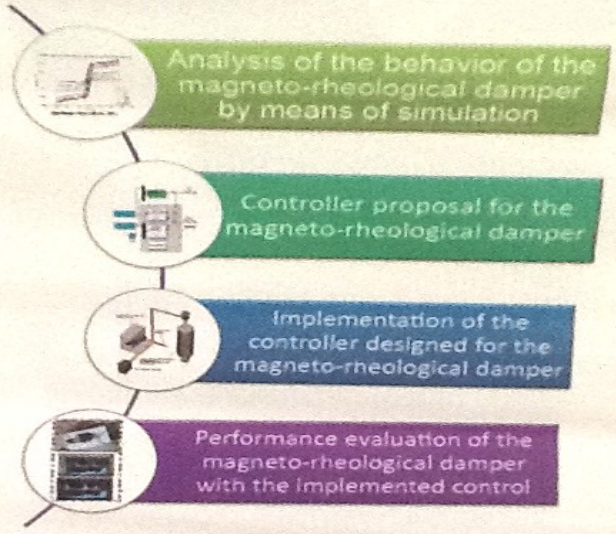


Figure1. Methodology utilized in this research

Mathematical analysis

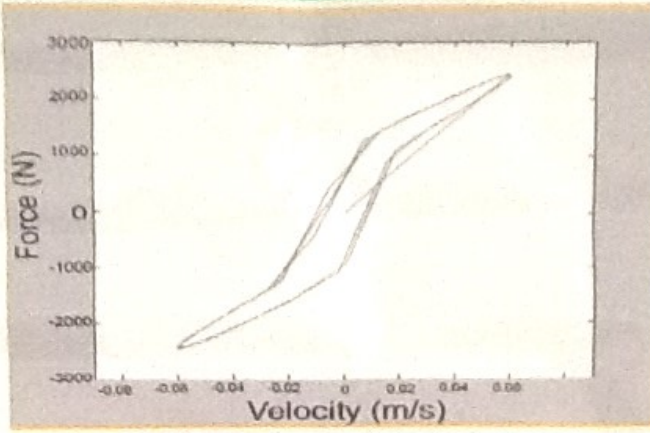
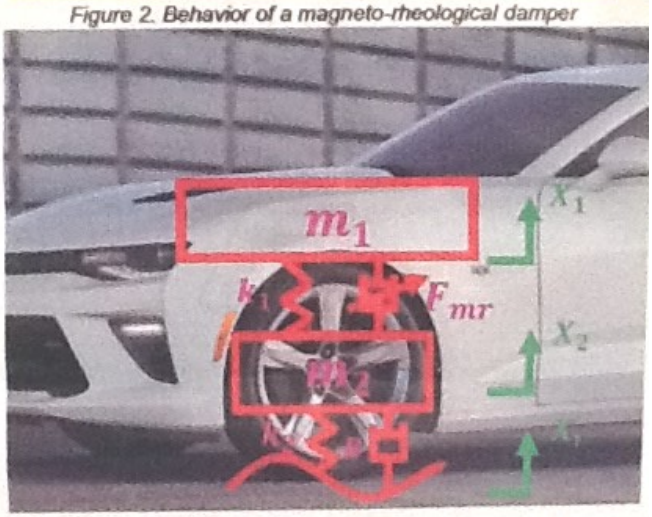


Figure 2. Behavior of a magneto-rheological damper



Fmr is the force provided in magneto-rheological damper

$$m_1\ddot{x}_1 + k_1(x_1 - x_2) + F_{mr} = 0 \qquad \text{Ecu.1}$$

$$m_2\ddot{x}_2 - k_1(x_1 - x_2) - F_{mr} + k_2(x_2 - x_r) + B(\dot{x}_2 - \dot{x}_r) = 0 \qquad \text{Ecu.2}$$

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \\ \dot{X}_4 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ \frac{-k_1}{m_1} & \frac{k_1}{m_1} & 0 & 0 \\ \frac{k_1}{m_2} & \frac{-(k_1+k_2)}{m_2} & 0 & \frac{-B}{m_2} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{-1}{m_1} & 0 & 0 \\ \frac{1}{m_1} & \frac{k_2}{m_2} & \frac{B}{m_2} \end{bmatrix} \begin{bmatrix} F_{mr} \\ X_r \\ \dot{X}_r \end{bmatrix}$$

Figure 3. Mathematical modeling of system dynamics

Test bench implementation

Figure 4. Test bench implementation

4. Results

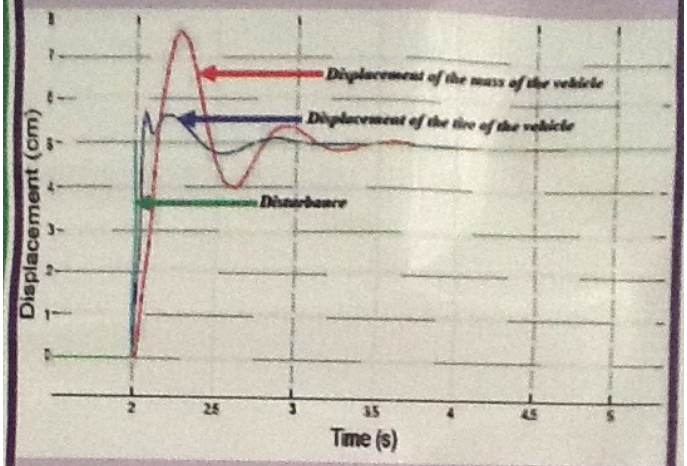


Figure 6. Response of the passive suspension system.

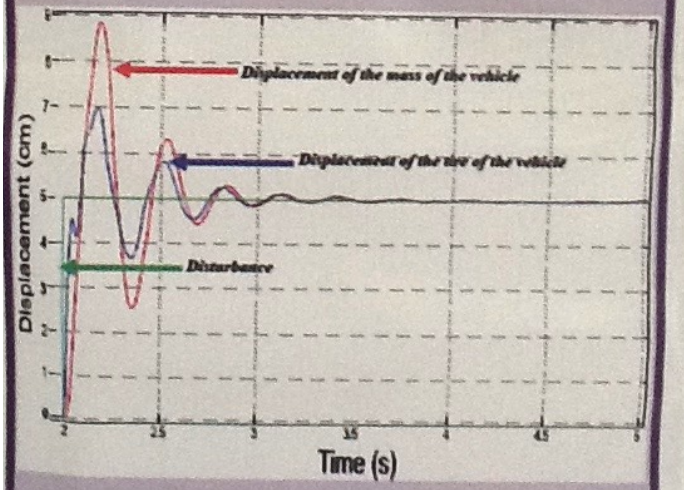


Figure 7. Response of the semi-active suspension system.(Model Dynamic)

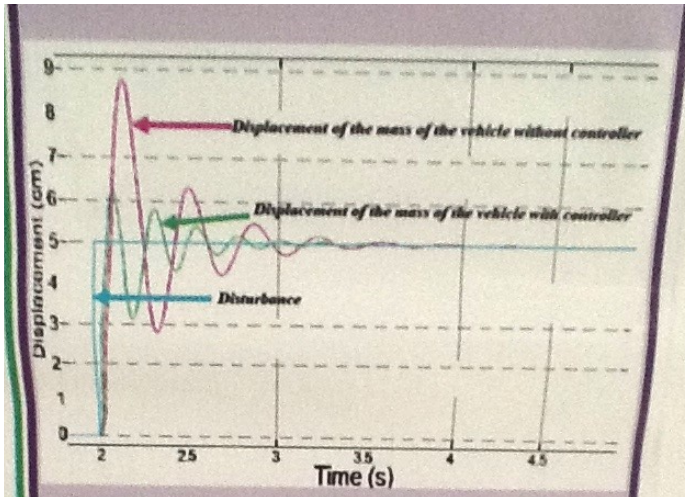


Figure 8. Response of the semi-active suspension system with the controller

5. Conclusion

A mathematical model of a magneto-rheological damper has been identified and simulated.

The behavior of a suspension system, with magneto-rheological damper, has been obtained in simulation.

A PID controller, for the semi active suspension system of a quarter of a vehicle, has been tuned in simulation.

The test bench structure has been build in 2" structural steel.

Acknowledgements

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References

[1] S.Bhowmik y J.Hogsberg "Modelling and Control of magnetorheological damper New York, 2012 pp.1

[2]Chevrolet Camaro 2016[online] Chevrolet México 2016 Disponible en:http://www.chevrolet.com.mx/camaro-coupe-2016.html

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