



MODELING, SIMULATION AND INVESTIGATION OF VEHICLE SUSPENSION AND DESIGN OF ACTIVE CONTROLLERS

By

Yahia Mahmoud Abdel Wahab Hassan Elattar

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirement for the Degree of
MASTER OF SCIENCE
In
Mechanical Design and Production Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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Title of Thesis: Modeling, Simulation and Investigation of Vehicle Suspension and Design of Active Controllers.

Keywords:

Passive suspension system; active suspension system; PI; PDF; MATLAB

Summary:

This work is dedicated to study the dynamic performance of vehicle passive and active suspension systems. The dynamics of a twin-tube shock absorber is investigated. A non-linear mathematical model describing the dynamic performance of the twin-tube shock absorber was deduced. This deduced model was used to develop a computer simulation program using MATLABTM Simulink[®] software package for the studied shock absorber. The dynamic characteristics of the studied shock absorber were evaluated experimentally. The validated simulation program was utilized for the further investigation of dynamics of a vehicle equipped with passive suspension system.

The dynamic performance of vehicle equipped with an active suspension system is also studied. A design for quarter vehicle equipped with active suspension system is presented. Level control response of the vehicle is investigated to be improved by using a proportional integral derivative (PID) controller and pseudo derivative feedback controller (PDF). Selections of the controller's parameters are carried out to get minimum integral square error (ISE) and integral of the time absolute error (ITAE) separately. The results showed that the transient response of the vehicle level for the PD controller which finely tuned to minimize the ISE has the shortest settling time. Whereas the transient response of the vehicle level for PID or the PDF controllers which finely tuned to minimize the ITAE have the shortest settling time. The PDF controller showed negligible maximum percentage overshoot. While the PID showed a maximum percentage overshoot within 5%.

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Dedication

To the soul of my father, *Mahmoud Elattar*, rest in peace...

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