ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN AND MODELING OF ACTIVE SUSPENSION SYSTEM FOR PID & FUZZY LOGIC CONTROLLERS

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DOI: 10.5281/zenodo.827500

ABSTRACT
The body vibration by reverse dynamic efforts of the actuator based on controlled external source of energy. The system is shaped by implementation of PID and Fuzzy Logic Controller with primary gain setting and observed the performance of the both controllers for uncertain road trajectories. The effective parameters for investigating the performance measure of the system are vehicle body vertical movement, velocity and time to the regain stability. Basic PID and fuzzy logic controller's efficiency is observed in various aspects, advantages and pitfalls of these control methodologies are studied. It has been observed the performance of PID controller is good for smooth road, but the uncertain road profile affects its performance while FLC achieved the better result by its vary- able adjustment ability.

KEYWORDS: Active Suspension, PID, Fuzzy Logic Controller, MATLAB Simulation

I. INTRODUCTION
The active control is designed as fuzzy control inferred by using single input rule modules fuzzy reasoning, and the active control force is released by actuating pneumatic actuator. The excitation from a road profile is estimated by using a disturbance observer, and estimate is denoted as one of the variables in precondition part of the fuzzy control rules. A compensator is inserted to the counter performance degradation due to delay of the pneumatic actuator. The experimental result indicates that the proposed active suspension system improves much the vibration suppression of the car model,[1]. The present work aimed at developing an active suspension for the quarter car model of the passenger car to improve its performance by using the proportional integral derivative (PID) controller. The controller design dealt with the selection of proportional, derivative gain and integral. The results show that the active suspension system has reduced the peak overshoot of sprung mass displacement, sprung mass acceleration, suspension travel and tire deflection compared to passive suspension system[2]. The presented work aims to construct control system simulated by using MATLAB.

The systems with active control can improve its qualities through the addition of the active shock absorber, which generates instantaneous forces making it possible to the support loads and to ensure the safety and comfort against the constraints [4]. Main drawback of Active suspension is that the actuation energy fed to the system from external source is leading to increase system cost [5]. So far various control approach introduced for the active control in suspension system application such as back stepping control [6], sliding the control [7], Fuzzy control [8, 9], adaptive sliding Fuzzy control [10] and intelligent control [11, 12]
For control is critical need in many in the many industrial processes. The control action of the chemical industries maintaining the controlled vibration. In this paper, we control the flow via two methods i.e. PID and FLC. PID control is one of the earlier control strategies [3]. PID controller has simple control structure which is easy to understand, but response of the PID control is not fast to overcome these problems we use the fuzzy logic controller. Performance analysis of the PID and FLC has been done by use of the MATLAB and simulink. Comparison of the various time domain parameters is done to prove that the FLC has small overshoot and fast response as PID controller.

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II. SYSTEM MODELING

A. Active suspension System

Active suspension system has an ability to store, dissipate and to introduce energy to the system. The hydraulic actuator is connected in parallel with a spring and absorber. While, sensor of the body are located at different points of the vehicle to measure the motions of the body. It may vary its parameters depending upon operating conditions. Figure 1. Shows the active car suspension system.

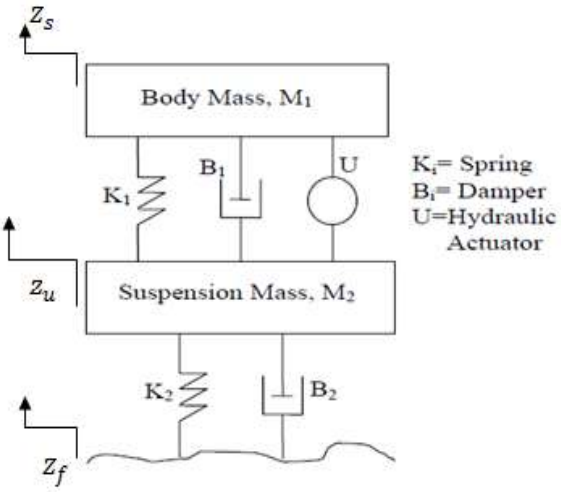

Fig.1:The active car suspension system

A physical active car suspension system in fig.2 is used to analyses the ride performance, where M1 and M2 are spring mass and un-spring mass in kg respectively. Suspension spring stiffness, K1 (N/m) and damping coefficient B1 (N-s/m) are considered as constants, being independent of time since in the present work active suspension system is analyzed. K2 is the tire stiffness in (N/m) and the tire damping coefficient B2 (N-s/m). Displacement of the spring mass, un-spring and road input is designated as Zs, Zu, and Zf respectively. Ordinary differential equation (ODE) are derived from fig2. as Eqs. 1 & 2 corresponding to the spring and un-spring mass respectively.

$M_1 \ddot{Z}_s + B_1(\dot{Z}_s - \dot{Z}_u) + K_1(Z_s - Z_u) + M_1\text{g} + U = 0$ 1
$M_2\ddot{Z}_u - B_1(\dot{Z}_s - \dot{Z}_u) - K_1(Z_s - Z_u) + B_2(\dot{Z}_u - \dot{Z}_f) + K_2(Z_u - Z_f) + M_2\text{g} = 0$ 2
Equation 1 & 2 are solved by a SIMULATION tool box of MATLAB.

B. PID Controller

The displacement of the servo valve is a controlled by Proportional Integral Derivative (PID) control. The PID controller combines system motion information, allowing generation of the synthesized control signal. The PID controller is chosen to complete the mathematical model and to investigate the hydro pneumatic quarter car model.

$$K(s) = K_P + \frac{K_i}{s} + K_d S$$

Here, kp represents a proportionality coefficient, ki an integral coefficient and kd the differential coefficient. These feedback coefficients can be adjusted to the obtain best control efficiency. In r(s) is the input signal, K(s) is the controller, G(s) is the plant and (y) is the feedback signal which is the displacement of the piston.

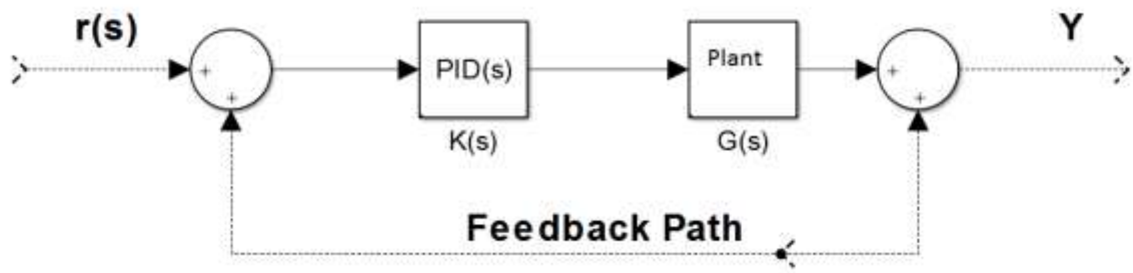

Fig2. Schematic diagram of the Proportional Integral Derivative(PID) controller

The Simulink model of the PID controller through numerical simulation experiments adopting a wide range of the control parameters, found that the approximate optimum set kp = 4.6, ki = 2 and kd = 0 produced the best control efficiency for the system

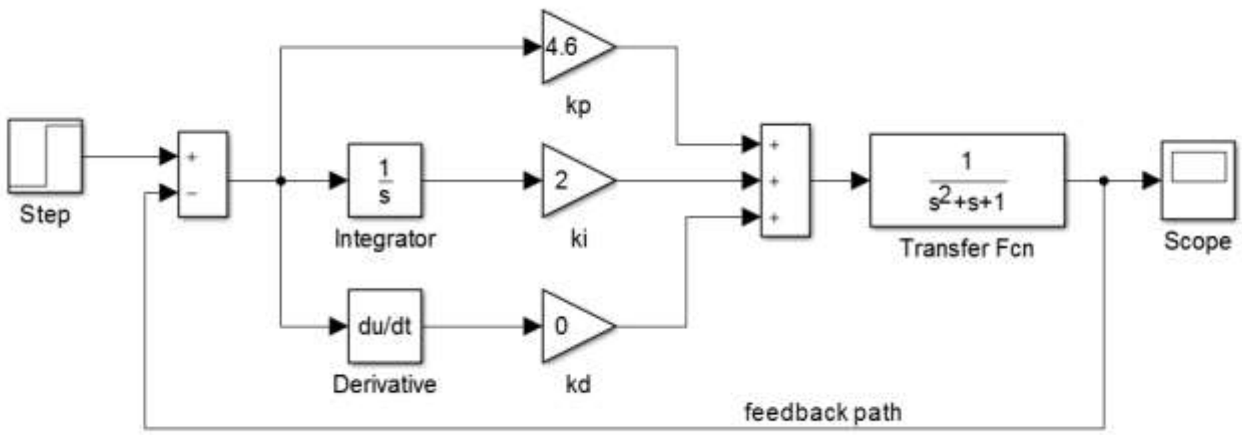

Fig. 3: Simulink Model of PID Controller

C. Fuzzy Logic Controller :

The SIMULINK Toolbox is used to build and test the complete suspension system. Figure 4. shows the complete half suspension system with all components needed for simulation including the designed FLC. The resulting FIS model is then tested using the SIMULINK Toolbox, which also gives the convenience of building and analyzing dynamical systems graphically. Simulink found that the approximate optimum set ki = 0.2 , kd = 0.05 and Fuzzy logic controller 'tank.fis' produced the best control efficiency for the system

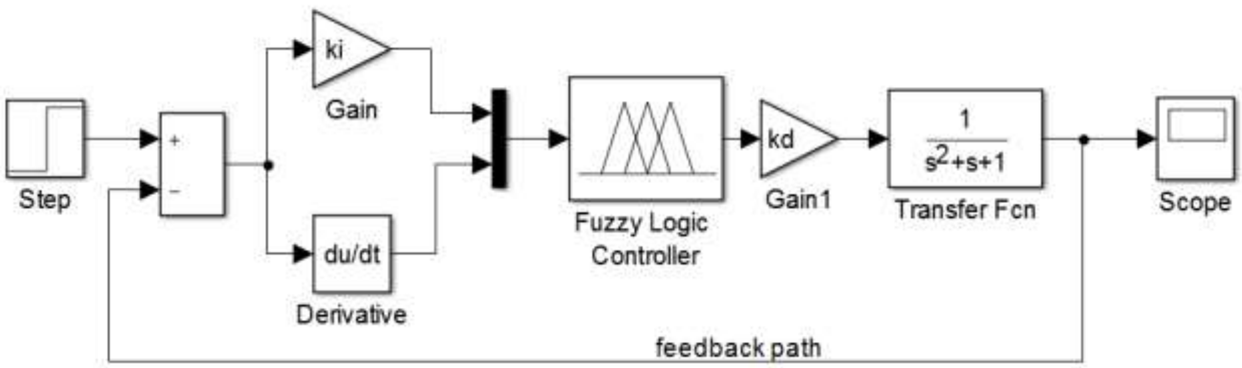

Fig. 4: Simulink Model of FLC Controller.

Figure.4: shows the simulink model of the fuzzy controller with unity feedback. Figure. show the fuzzy membership function is chose, such as trapezoidal, triangular and Gaussian according to the process parameter. In this paper it is suitable to choose triangular and trapezoidal.

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III. MATLAB SIMULATION RESULTS

The Fig. 3 and 4 shown the response of PID controller and the response of fuzzy logic controller to the step input.

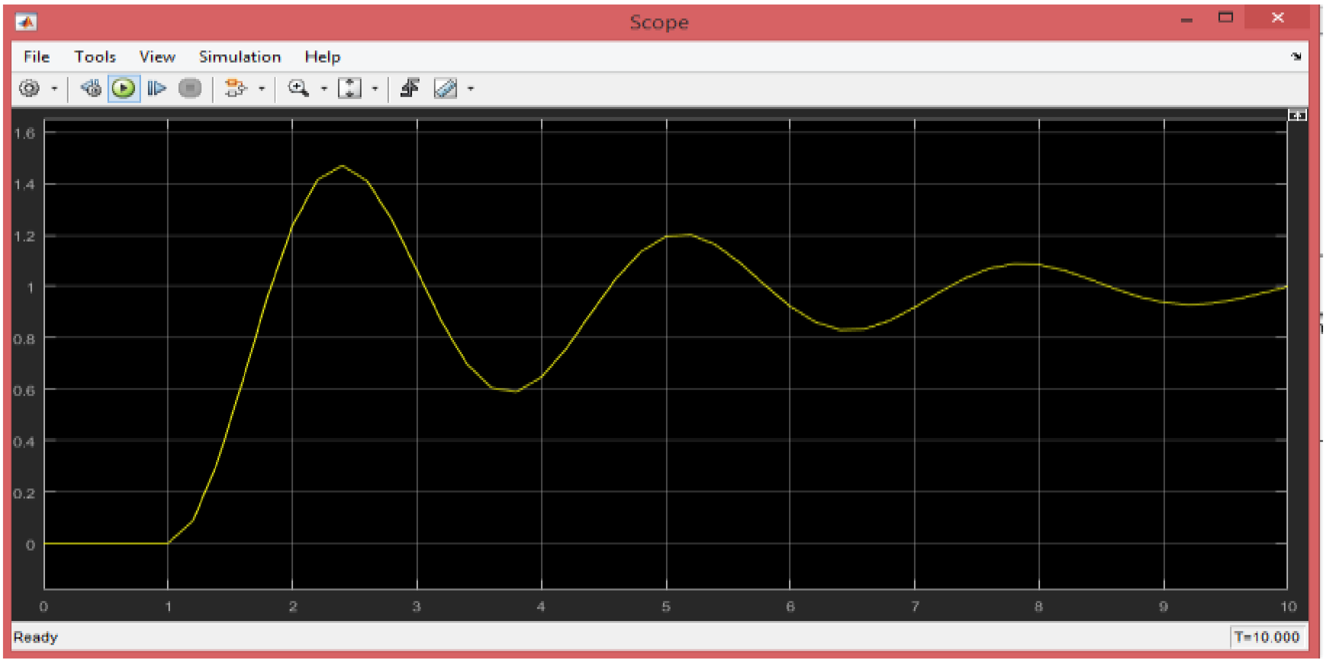

Fig.3: The step response of the PID controller

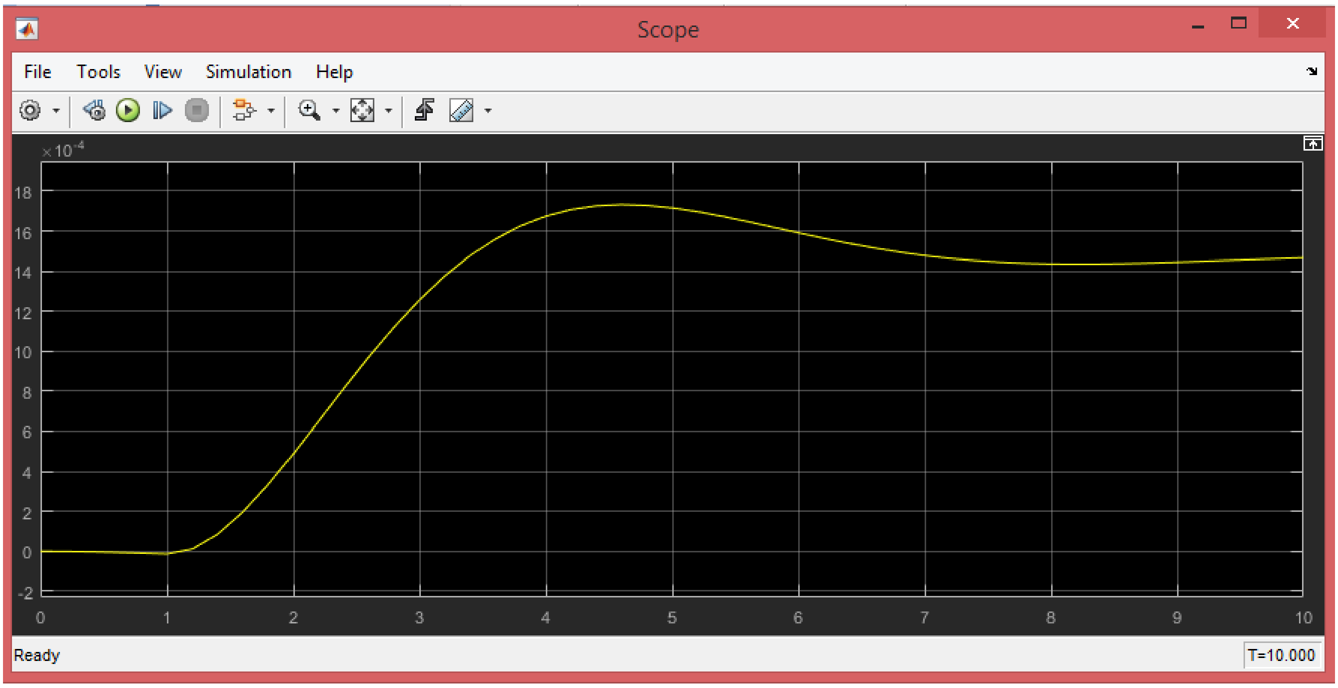

Fig.4: The step response of the fuzzy logic controller

IV. CONCLUSION

In this paper, we design two kinds controllers which is PID and fuzzy logic controller .

- From the figure, results shown that response of the PID controller is oscillatory which can damage the system. But the response of fuzzy logic controller is free from these dangerous oscillations in the transient period. Hence proposed of the fuzzy logic controller is better than the PID controller.

- It could possible PID can gives the better results than FLC for the particular designed conditions but if operating parametric uncertainty is there then efficiency of the PID tremendously get reduce and apart from this FLC have the ability to changes its design variables in response to the input values to the meet desired response..

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CITE AN ARTICLE

Yadav, Ripujya , and M. Siva Kumar. "DESIGN AND MODELING OF ACTIVE SUSPENSION SYSTEM FOR PID & FUZZY LOGIC CONTROLLERS." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 302-06. Web. 15 July 2017.