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Developing and Modelling Fuzzy Controlled Suspension

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Abstract: *Through an intelligent adaptation to road conditions, modelling and design of a fuzzy controlled suspension system will enhance vehicle dynamics and ride comfort. Compared with the conventional methods, this technology provides a smoother response by approximating the human reasoning on suspension dynamics control using the fuzzy logic. The fuzzy controller can adjust damping forces dynamically due to the fact that the model has sensors that are used to assess real time signals such as vehicle dynamics and road imperfections. The effectiveness of the technology is confirmed by the results of simulations that indicate improved stability and vibration mitigation. This paper explains the use of fuzzy control in an automotive suspension to help enhance safety and comfort of driving under different conditions.*

Keywords: *Neural network, Intelligent controller, Fuzzy, Overshoot, Quarter car model, Simulation.*

I. Introduction

Suspension systems are crucial to the performance of a car because they keep the car stable, ensure the comfort of the passengers and absorb the shocks caused by the rough roads. The traditional suspension systems are often unable to achieve a compromise between handling and ride comfort, especially on variable roads. Offering a possible alternative, developing a fuzzy-controlled suspension system is possible through dynamic adjustment of suspension parameters in real time using fuzzy logic. This approach can deal with the uncertainties and non-linearities involved in vehicle dynamics by modelling human decisions. Modelling such a system by simulating and optimizing control algorithms would help improve the overall ride quality, safety and adaptability in numerous driving scenarios.

II. Mathematical Modelling

In mathematical modelling of a fuzzy controlled suspension, the suspension dynamics of the vehicle are represented by equations describing forces, and motion. A quarter-car model system is normally simplified to sprung and unsprung masses connected with springs and dampers [1]. The suspended behaviour is governed by differential equations which consider the stiffness of the springs, damping forces and the road inputs. The fuzzy controller dynamically changes the damper force by calculating control signals inputs supplied as variables including the suspension velocity and displacement. This modelling can simulate-optimise fuzzy rules and membership functions to give improved handling and ride comfort by modelling the non-linear, unpredictable behaviour of real suspension systems.

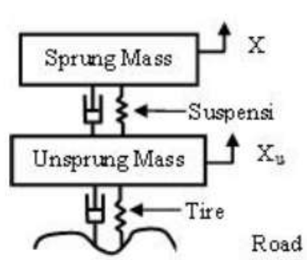

Fig 1: Mathematical modelling for car

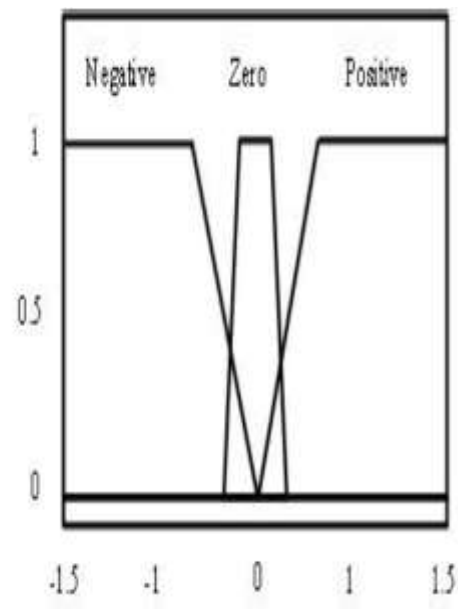

Fig 2: Membership function for every input

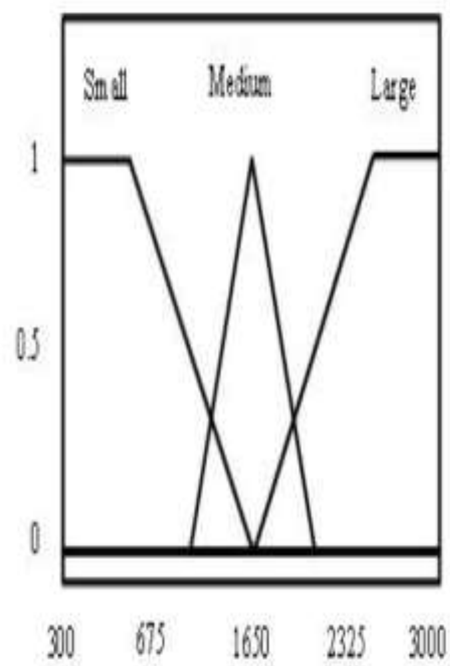

Fig 3: Membership function for every output

III. Fuzzy Controller

In a fuzzy controlled suspension system, the fuzzy controller uses fuzzy logic to modify the damping forces of the suspension system based on vague and uncertain inputs. It converts measures of such quantities as velocity and suspension displacement into verbal expressions such as small, medium and large [2]. A controller selects the optimum damper settings to enhance ride comfort and stability according to a set of fuzzy principles. It can handle nonlinearities and varying driving conditions more effectively than typical controllers because it is capable of simulating human reasoning. The suspension systems require flexible and real-time response due to which fuzzy controllers are ideal in reducing vibrations and maintaining the stability of the vehicle.

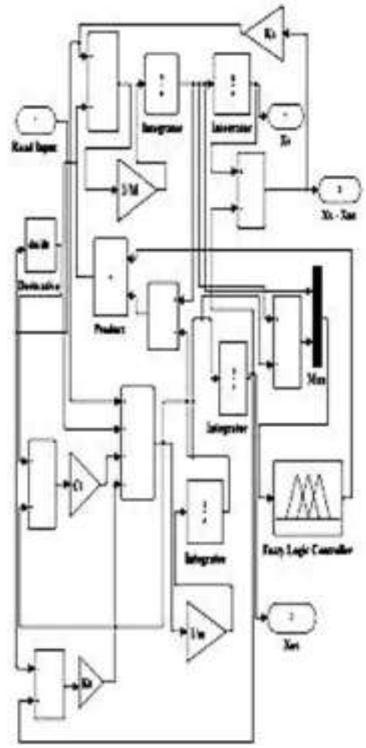

Fig 4: Control suspension for fuzzy logic

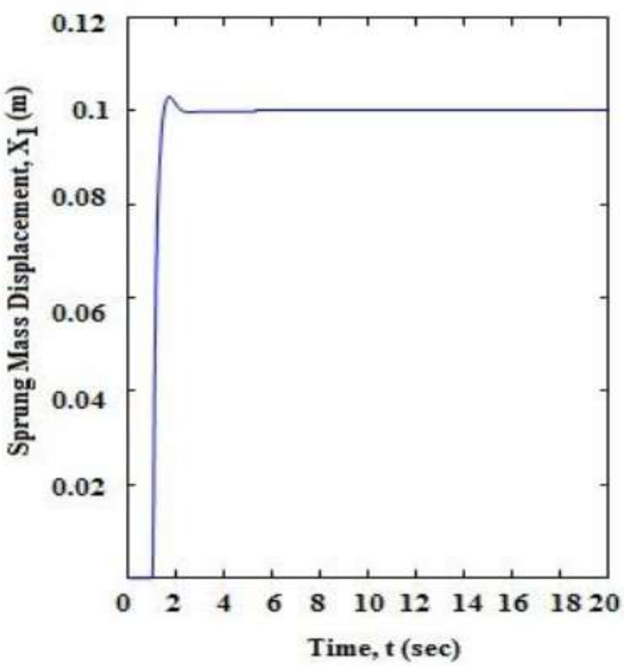

Fig 5: Control Suspension of spring vs time

IV. Simulation and Results

Fig. 6 displays the fuzzy controlled suspension simulation model. For road input, the model is simulated as a step function with a value of 25 cm. Figures 6 displays the settling time response and the sprung and unsprung mass displacement.

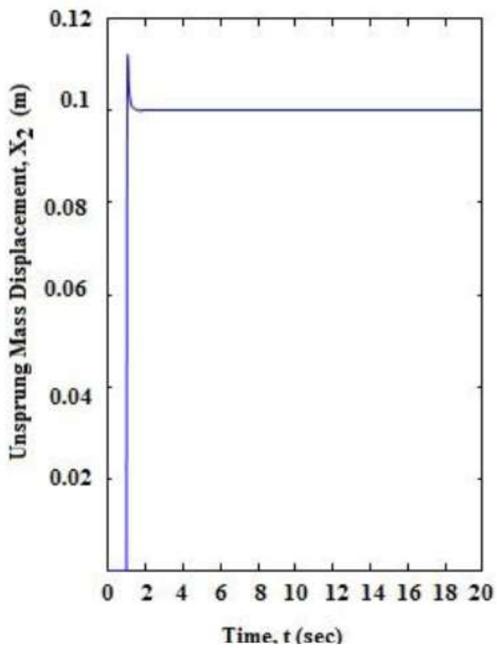

Fig 6: Control Suspension settling time response and the sprung

V. Conclusion

The fuzzy-controlled suspension system enhances comfort for passengers by improving ride stability and adapting intelligently to varying road conditions. It is a good way to design active suspension because it outperforms conventional techniques in dealing with non-linear factors and uncertainties. Overall, fuzzy control systems improve safety and increase enjoyment while driving in numerous scenarios.

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