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Intelligent Automatic Car Braking Control System Using Neural Network Classifier

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ABSTRACT: - Protection structures in street automobiles are classified into two fundamental sorts: passive and energetic systems. The Intelligent braking machine (IBS) is an active protection device in road cars, which senses the slip value among the tyre and the road and uses these values to determine the gold standard braking pressure. due to the high non-linearity of the tyre and avenue interplay, and uncertainties from automobile dynamics, standard manipulate methods: like PID, sliding mode manipulate and feedback linearization will not suffice.The performance of the Intelligent Brake Control is assessed with a full vehicle model, sustained by vehicle dynamic principles. The model is integrated with brakeline dynamics and a tire friction model based on reliable simulational data. Straight line brake simulations are performed and results are evaluated in terms of braking efficiency, under different and variable conditions.

This paper, consequently proposes a neural network-based totally remarks linearization manage design approach. The simulational outcomes monitor that slip law the usage of neural community-based totally manage scheme is possible for distinct slip values (avenue situations) and robust to outside disturbances.

Keywords: *Intelligent braking machine, slip manipulate, neural community, model*

I. INTRODUCTION

The effects of road accidents on lives and properties cannot be overemphasized.so any vehicle without an effective brake system is prone to accident and apparently disastrous effect follows. The purpose of automated car braking system is to develop an automated control system that would maintain a safe driving distance from obstacles while driving. This research work proposes a car braking system that will be controlled by the artificial neural networks to curb road accidents and effectively assure safety and stress free driving. In many road accident cases, a major cause of the accident is the driver distraction and failure to react in time (Aldair,, 2010). Advanced system of auxiliary functions will be developed to help avoid such accident and minimize the effects of collision in effect. This will be achieved by reducing the total stopping distance through works done by researchers in the past. Lately some of the works will be used in many car brake system developments deploying electronic brake control system which has led to significant safety in driving

(Baslamisli, 2007) proposes a back stepping control design scheme for a non-linear ABSassisted with active suspension system (ASS) to further reduce vehicle braking time and stopping distance. The goal is to utilize the vertical normal force that increases during braking, leading to increased frictional forces between the tyre and the road to achieve more shorter stopping distance than using just ABS. Simulation results using a quarter-car model show that the integrated system achieved a 12% improvement in stopping distance.

The feedback linearization control (FBL) method as applied to non-linear systems is one method to turn to for solving the slip control problem. However, there exists minimum literatureon the application of feedback linearization control method to ABS. (Chin et al, 1992) presented simulation results of a wheel slip control employing the feedback linearization control method with an adaptive sliding mode control. The novelty of this work is the introduction of a time delay to the input. The time delay is necessary because in practice, there exists a time delay in the actuator dynamics. To compensate for the time delay, the sliding mode controller is incorporated to bound the uncertainties, using a method proposed by (Blanchett et al, 2000). The simulation results presented did not show a significant difference between the models incorporating time delay to the model without the time delay.

1.1 Problem statements

1. Overspeeding
2. Careless drivers
3. Accidents

1.2 Aim

The aim is to develop automated break control system

1.3 Objectives

1. To design automated break control
2. To implement the develop model in (1) using matlab Simulink

1.4 Scope

This report is limited to the design of automatic brake control system with artificial neural network. An automatic brake control system using artificial neural network will be designed to reduce acceleration from a predetermined speed once it detects an obstacle 100m ahead. Two inputs and one output parameters; position, velocity and brake, will be designed using Fuzzy logic toolbox, to develop the car brake controller while Simulink based on back propagation training algorithm will be used to train the network

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II. REVIEW OF RELATED WORK

Choi(2008)Applied a predictive approach to design a non- linear model-based controller for the wheel slip. The integral feedback technique is also employed to increase the robustness of the designed controller. Therefore, the control law is developed by minimizing the difference between the predicted and desired responses of the wheel slip and it's integral.Huang(2010) proposed a static-state feedback control algorithm for anti-lock brake system (ABS) control. The robustness of the controller against model uncertainties such as tire longitudinal force and road adhesion coefficient has been guaranteed through the satisfaction of a set of linear matrix inequalities.A neuro-fuzzy adaptive control approach for nonlinear system with model uncertainties in Intelligent braking systems was proposed .The control scheme consists of PD controller and an inverse reference model of the response of controlled system. Its output is used as an error signal by an online algorithm to update the parameters of a neuro-fuzzy feedback controller

Layne(2013) Described a quarter-vehicle and an ABS in MATLAB-SIMULINK known as the SWIFT-tire model. This has relevance in modeling the tire characteristics and the dynamic behavior on a flat as well as an uneven road. From the performance of ABS with variation of weight, friction coefficient of road, road inclination etc. a self-tuning PID control scheme to overcome these effects via fuzzy GA is developed; with a control objective to minimize stopping distance while keeping slip ratio of the tires within the desired range

Li (1998). An intelligent controller can be used to design a control system for a full vehicle nonlinear active suspension system such as Neural Controller (NC). Neural Networks (NNs) are capable of handling complex and nonlinear problems, process information rapidly and can reduce the engineering effort required in controller model development. Artificial neural networks are made up of a simplified individual models of the biological neuron that are connected together to form a network. It consists of a pool of simple processing units which communicate by sending signals to each other over a large number of weighted connections. Capability of learning information by example; ability to generalize to new input and robustness to noisy data are the important properties of neural networks. From these properties, neural networks are able to solve complex problems that are currently intractable. The artificial neural network is an intelligent device wildly used to design robust controllers for nonlinear processes in engineering problems. In many publications, neural networks are used to design controllers, such as the model reference adaptive control, model predictive control, nonlinear internal model control, adaptive inverse control system and neural adaptive feedback linearization. The control architectures in these papers depend on designing a neural network identifier and then this identifier is used as a path to propagate the error between the output of the process and output of the reference model to train and select the optimal values of the neural network control. Therefore, in those methods two neural networks were trained to track several control objectives

One of the main advantages of using a neural network as a controller is that neural networks are universal function approximations which learn on the basis of examples and may be immediately applied in an adaptive control system because of their capacity to adapt in real time. There are many learning algorithms available to obtain the optimal values of the trainable parameters of neural network. The back-propagation algorithm (BPA) has been known as an algorithm with a very poor convergence rate. The Levenberg-Marquardt Algorithm (LMA) is an iterative technique that locates the minimum of a multivariate function that is expressed as the sum of squares of nonlinear real-valued functions (Layne, 2013). To improve the riding comfort and road handling, a neural network controller for full vehicle nonlinear active suspension systems with hydraulic actuators has been proposed by the authors. In this paper Fractional Order PID (FOPID) will be designed for full vehicle nonlinear active suspension using the Evolutionary Algorithm (EA). The data obtained from the FOPID controller are used as reference to design the neural controller. The LevenbergMarquardt training algorithm has been used to obtain the optimal values of the trainable parameters. The performance of the neural controller has been improved by adding the Scaling Gains. The scaling gains of the neural controller have been adjusted using Golden Section Search (GSS) method. The effectiveness and robustness of the proposed neural network controller and FOPID controller will be compared. Six types of the disturbances will be investigated to establish the robustness of the proposed controller. The results will show whether the proposed controller is more robust than the FOPID controller

III. METHODOLOGY

3.1 Design of the Neural Controller

Neural Networks (NNs) are capable of handling complex and nonlinear problems, process information rapidly and can reduce the engineering effort required in controller model development. Figure 3.3 depicts the controlled vehicle system with a neural controller as a key component. A neural controller has been designed to generate suitable control signals. The control signals will be applied as a control input signals to govern the hydraulic actuators to generate suitable damping forces for improving the vehicle performance. To find the optimal values of the trainable parameters of the neural controller for driving the plant to meet all control objectives, FOPID controllers was designed. The input and output was used to train the parameters of neural controller using the LM Training Algorithm. Figure 3.4 depicts the training phase of the Neural Controller.

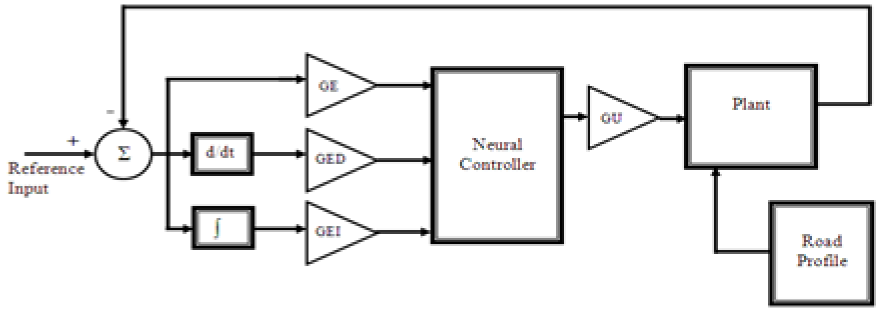

Figure 3.1: Neural Controller for a Full Vehicle Model

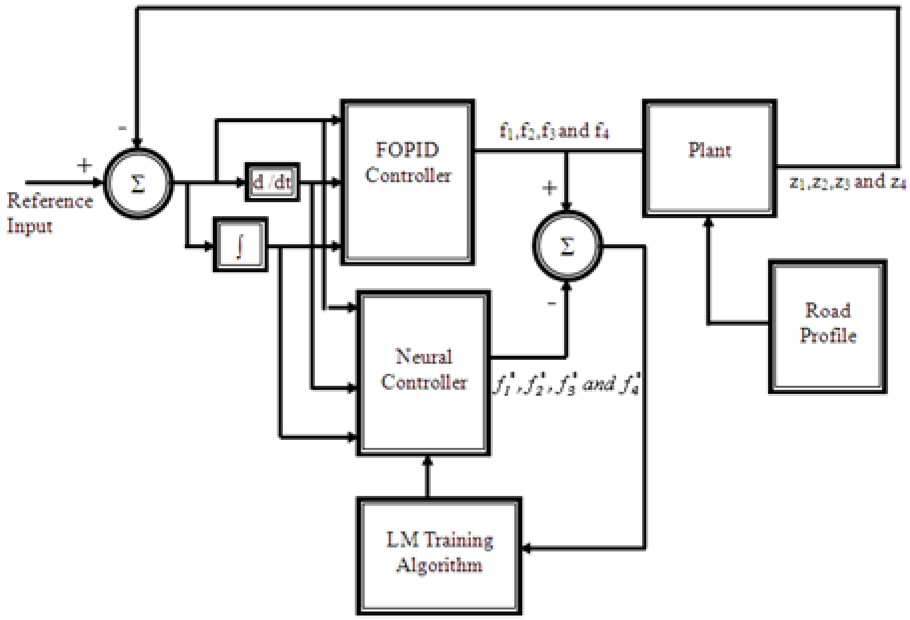

Figure 3.2 Training Phase of Neural Controller

After the optimal values of trainable parameters are obtained the neural controller design should be improved by adjusting the scaling gains, i.e. GE, GED, GEI and GU, as shown in Figure 3.1. To select the optimal values of the scaling gains, four-dimensional Golden Section Search (4-D GSS) method is introduced to reduce the trial time

IV. RESULT AND DISCUSSION

4.1 Result Algorithm for the training Machine

The rule base of the longitudinal control generated by the Neuro-fuzzy system is described by the following rules:

IF Speed_error***Negative*** **AND** Acceleration ***Negative***
THEN *Output* **a05**
IF Speed_error***Negative*** **AND** Acceleration ***Positive***
THEN *Output* **a02**
IF Speed_error***Negative*** **AND** Acceleration ***Null*** **THEN**
Output **a03**

IF Speed_error***Positive*** **AND** Acceleration ***Negative***
THEN *Output* **a06**
IF Speed_error***Positive*** **AND** Acceleration ***Positive***
THEN *Output* **a07**
IF Speed_error***Positive*** **AND** Acceleration ***Null*** **THEN**
Output **a09**
IF Speed_error***Null*** **AND** Acceleration ***Negative*** **THEN**
Output **a01**
IF Speed_error***Null*** **AND** Acceleration ***Positive*** **THEN**
Output **a04**
IF Speed_error***Null*** **AND** Acceleration ***Null*** **THEN**
Output **a08**

4.2 Result for Real Time Brake Response

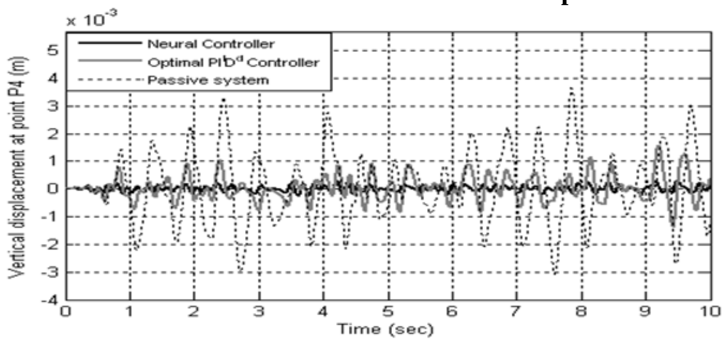

Fig 4.1: Time response of vertical displacement

4.3 Neural Network Result Analysis of Vehicle and Wheel

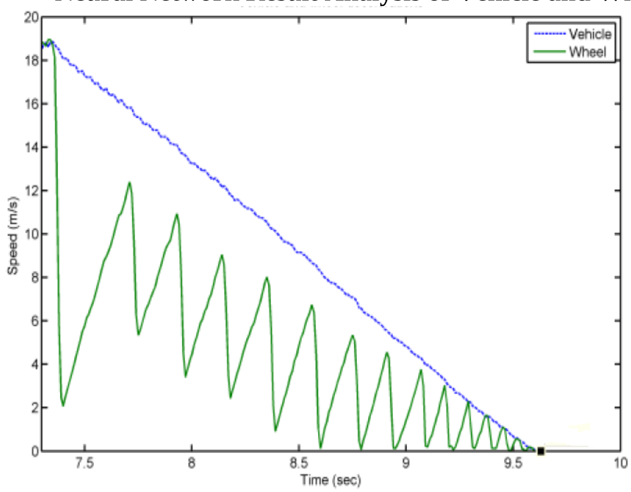

Figure 4.2: Simulational results for deceleration of vehicle and wheel using NNFBL controller for the case of slip regulation

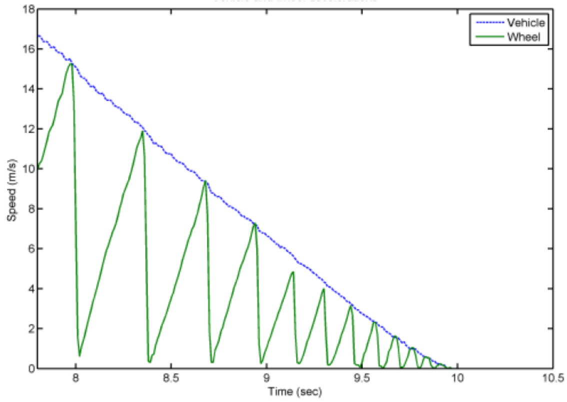

Figure 4.3: Simulational results for deceleration of vehicle and wheel using PID controller for the case of slip tracking

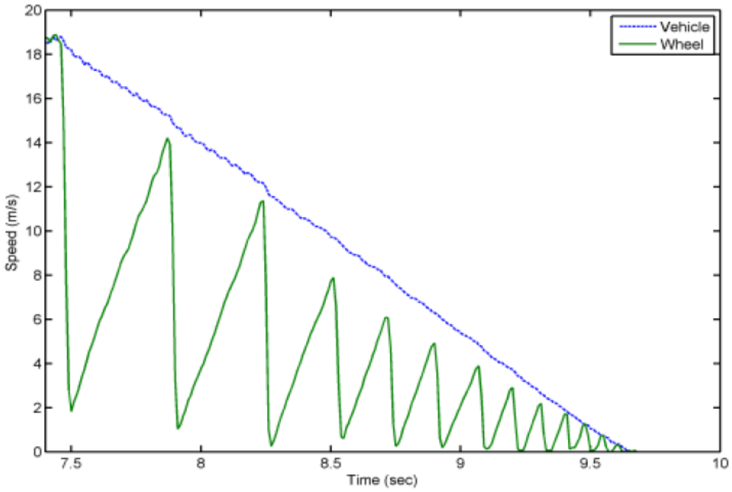

Figure 4.4: Simulational results for deceleration of vehicle and wheel using neural network controller for the case of slip tracking

Considering the plots of the slip regulation, the PID controller exhibits higher slip values thanthe NNFBL controller, before the end of the simulation. The NNFBL records high slip values only towards the end of the simulation, reaching its maximum peak value as expected in reality. The NNFBL recorded the lowest effective braking torque of 39Nm compared to the 108Nm by the PID controller.The results of the deceleration of the vehicle and wheel show the NNFBL performed better than the PID by recording the lowest stopping distance of 20:75m as against 22:17m by the PID controller.Considering the plots of the slip tracking case, a reference slip trajectory is imposed. This is done to imitate changes in road condition, thereby evaluating the robustness of the controllers. Similar to the case of slip regulation, braking commenced at an initial longitudinal velocity of 68km=h (1500rpm) until rest. There was no further tuning of the controllers so that the robustness of the controllers could be evaluated

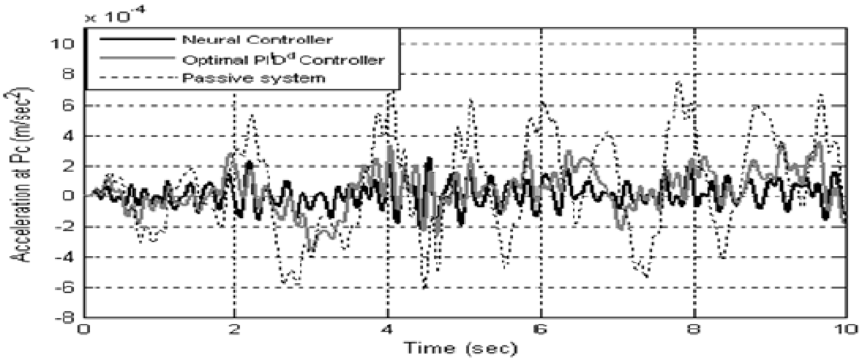

Fig 4.5: Time response of acceleration

The efficient controller is the controller that is still stable even the disturbance signals are applied on the plant. Therefore, to establish the effectiveness of any controller the robustness should be examined. After the optimal values of the trainable parameters of the neural controllers have been obtained, the robustness of the proposed neural controllers with optimal values should be tested. Six types of disturbances are applied in turn to test the robustness of the neural controller.

V. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

During system validation, several simulated data was used to test the system under relative velocities, and initial 100m separation distances conditions, the sensor read the velocity of the object directly in front of it and the position of the vehicle from the object. Validation confirms that the automatic brake control system brought the vehicle at rest within the desired safety. Situations where stopping the vehicle without collision was possible, the system consistently applied sufficient and appropriate brake pressure to stop the vehicle in time. Other cases where an accident was physically unavoidable, the control system will still reactimmediately and applied a significant amount of brake pressure, minimizing the vehicle velocity at impact perhaps, reducing the significance of the collision.

VI. RECOMMENDATION

Neuro-fuzzy structures have many programs in ITS location. Designing, tuning and implementation of the lateral control can be taken into consideration for destiny works. Furthermore, neuro-fuzzy strategies will be used to version the behavior of the car, and we think that this will help us to improve the present day controllers in the autonomous driving.The longitudinal control can also be progressed if different variables are thinking of inside the manage loop. In future works, a multivariable system, considering longitudinal and transversal variables, may be designed. Furthermore, the weather element can also be taken into consideration.

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