IJDACR
ISSN: 2319-4863

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 3, Issue 1, August 2014)

Comparison in Honda Algorithm and Neural Network for Anti Cruise Collision Avoidance System

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Abstract: **The need of security in transport system is necessary to prevent accidents. The automated approaches manage the speed of vehicles in accident prone situations. Anti Cruise Control (ACC) maintains a safe distance among two vehicles and does not halt the cars which is added benefit for traffic management. In this paper, two approaches are considered for anti cruise control: Honda Algorithm and Neural Network. Simulations show that the result of Honda Algorithm is better than NN for speed regulation and keeping the safe distance against the leading car. Neural Network is trained to produce desired throttle and brakes. Back Propagation and Radial Basis Neural Networks are implemented for this and the system is tested on MATLAB 2012 (b) SIMULINK model.**

Keywords: **Anti Cruise Control, Neural Network, Back Propagation, Radial Basis, Honda Algorithm, Speed**

1. INTRODUCTION

An automated approach for prevention of accidents is called as collision avoidance system. Air transport is installed with a version of these systems and strictly follows the guidelines related. In road transport, where the traffic density is much higher, two important aspects are needed to be considered: accident probability and traffic management. Many methods have been evolved over the time as automated braking system, monitoring of driver's consciousness and GPS tracking. However, looking at the present accident records published (by WHO) a necessity of better automated controlling is required in vehicles.

Collision Avoidance System (CAS) is enhanced version of Collision Mitigation System (CMS). CAS functions in the first stage of Haddon Matrix [1]. Efficient algorithms for early brakes are necessary to completely prevent accidents. The overall response time and accuracy of output determines the efficiency and reliability of assessment algorithms. In comparison with CMS, CAS is quicker in response time as intervention is performed much earlier in this case.

In this research, the focus is concentrated on first part of problem. The anti-cruise system for collision avoidance is the intelligent system that regulates the speed of car based on the speed of front car and distance among both the cars. The system controls the throttle and brakes of a car and could be architected either to warn the driver or automatic control the speed. Here, second scenario is considered as, the vote for accident avoidance is high in this case. The ACC is installed in a car and another car for reference is selected that runs ahead of it. The car in rear constantly monitors the distance and speed of front car. In case if the distance exceeds the limit of safe threshold, ACC degrades the speed of car and maintains the distance. In case if the car is exceeds the maximum distance among both car, ACC accelerates the rear car, in order to keep the communication link among both the cars. This system does not halt the car until very necessary that is beneficial in many aspects. First, the traffic is not block as the car does not block the way, second the

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driver does not need to every time control a car unless to turn the direction or overtake a car.

In this paper, two approaches: Honda Algorithm and Neural Network are employed to test their intelligence in efficient speed control. The Radial Basis NN and Back Propagation NN were good in their approaches but the proposed Honda Algorithm performed better in speed regulation and error response. The organization of paper is as follows: the second section is the literature review of various CAS techniques that determine the lower limits of performance scenario of proposed system which is proposed in third section. Fourth section presents the results of constructed method and a conclusion is present in the end.

2. Literature Survey

Over the years, many security techniques were introduced that were efficient in particular period of time. In this era, many automated techniques provide security in comparison with conventional methods.

Anti-Lock Brakes

Also known as Sure Track Braking (STB) [2] anti lock brakes was installed in Ford Thunderbird and Lincoln Continental Mark IIIs in the end of 1960s. These brakes prevented slipping of vehicle by providing a constrained motion to vehicles on applying brakes. This system was modified in later years and minicomputer was installed for automated controlling. The system was introduced under different titles for different vehicle manufacturers, e.g. Track Master (Cadillac), True Track (Oldsmobile), and Sure-Brake (Chrysler Imperial) [3].

Traction Control System

Traction Control System dealt with lateral (front to end) loss of friction in case of acceleration. In case of slippery roads, the system regulates the speed of vehicles to maintain necessary friction among the surfaces of wheels and roads. One way to envision TCS is realizing it is the opposite of ABS; concerned with acceleration and not deceleration (ABS).

Electronic Control Stability

ECS is a unified approach of ABS and TCS technologies and if the driver is found to have diverted attention, the system takes over the control and applies brakes to degrade the speed of vehicle. NHTSA mandated ESC once its effectiveness was proven, and by model year 2012 100 percent of vehicles were to be outfitted with this groundbreaking semi-autonomous vehicle technology [4].

Sensors

Authors of [5] [6] and [7] observed that most of the projects on vehicles with a collision avoidance system use cameras in order to build their environment. The authors in the same field tested single dimension sensors to analyze traffic on reduced cost and time. However, the results were not satisfactory on generalized frame of their applications.

Authors of [8] tested two black and white cameras with small and larger focal lengths for near and farer objects respectively. Results demonstrated that the required intensity for identification could not be achieved by standard camera quality.

A proximity sensor was developed that could sense the car in front [9]. This system generates an emergency signal based on collision probability.

Anti-cruise control system is a physical device that degrades the speed of car and generates warning to the driver. A sensor is placed in the front of car that constantly monitors the speed and distance of relative car. As it is clear from this discussion that most of the techniques either halts the car or generate warning, but anti-cruise degrades and also accelerates the car. Once switched on driver can rest without considering about collision probability. Hence it is mandatory that performance of anti cruise control should be precise and reliable. In next sections we will study about techniques that enhance the relative results of speed and error generation for the system.

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3. Neural Network for ACC Control

Standard back propagation is a gradient descent algorithm, as scripted in the works of Widrow-Hoff learning rule, the moves the network weights in accordance with the negative gradient of performance function. Back Propagation is the tool that computes gradient for nonlinear multilayer networks. The manipulation in basic algorithm are sourced and conditioned by various standard methods that include: conjugate gradient and Newton methods. The NN toolbox summarizes such methods in part of its implementation.

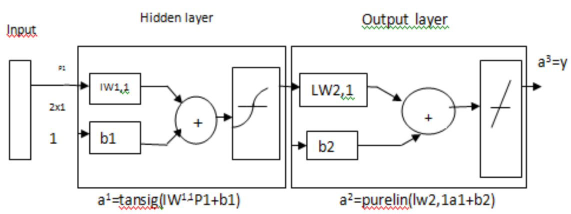

Figure 1: Architecture of Back Propagation Neural Network

A single or couple of mist layers in feed forward networks follows the resultant layer of linear neurons. Multiple layers of neurons that have nonlinear transfer functions simulate the network to entertain linear and non linear relations among input and output vectors. The network generates the values from -1 to +1 powered by linear output layer. For the constraints in the output i.e. range of 0 to 1, output layer uses a sigmoid transfer function (also known as logsis). Multilayer networks often use the log-sigmoid transfer function logsig or tan-sigmoid function tansig.

In comparison with the standard feed forward back propagation networks, radial basis looks for more number of neurons. This network on contrast consumes lesser time period in training against standard techniques. The true performance of RBNN is achieved with maximum numbers of training vectors. This function is a combination of three layers: Input, hidden and output. Neurons of hidden layer possess Gaussian transfer functions whose outputs are inversely proportional to the distance from the center of the neuron.

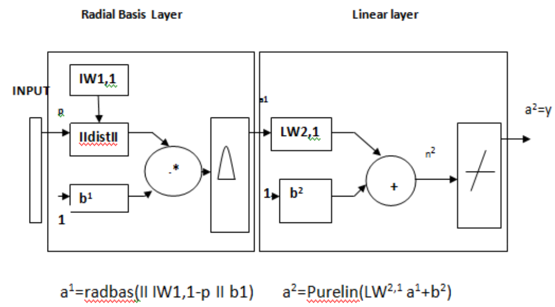

Figure 2: Architecture of RBN

4. Proposed Architecture

The Honda's warning algorithm is a straight line in the range rate-range plane, indicating a time-to-impact consideration. Their braking logic has two parts selected by estimated shortest time-to-lead-vehicle-stop.

The Honda algorithm [Fujita et al. 1995] uses the following warning criterion:

$$R_w = -2.2 \,.\, RR + 6.2 \tag{1}$$

which is based on the TTC1 measure with a constant distance headway offset of 6.2 m. Warning is issued when the TTC1, after offset adjustment, is below 2.2 s.

The Honda overriding algorithm also considers a hypothetical scenario, as shown in Figure 4.1. It consists of two parts, depending on whether the lead vehicle is expected to stop within the considered time range τ_2. It is assumed that the lead vehicle brakes constantly at deceleration level $-\alpha_2$ (if the estimated lead vehicle stopping time $t_{LS} \equiv v_L/\alpha_2 < \tau_2$) or $-\alpha_1$ (If $t_{LS} \geq \tau_2$), while the host vehicle starts to brake after reaction time τ1 at deceleration level $-\alpha_1$. The safety range R_o is estimated as the minimum range buffer needed to avoid collisions until τ_2 at both situations, which is represented by the shaded areas in Figure 4.2 and computed as follows:

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$$R_o = \begin{cases} v_H.\tau_2 - \frac{1}{2}\alpha_1(\tau_2-\tau_1)^2 - \frac{v_L^2}{2\alpha_2} & t_{LS} < \tau_2 \\ -RR.\tau_2 + \alpha_1\tau_1\tau_2 - \frac{1}{2}\alpha_1(\tau_1)^2 & t_{LS} \geq \tau_2 \end{cases} \quad (2)$$

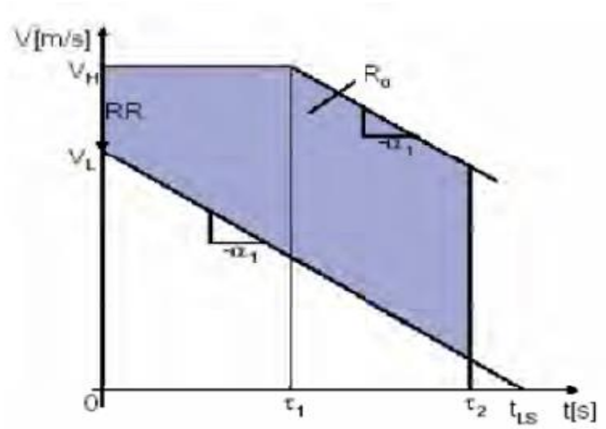

Figure 3: Interpretation of Honda Algorithm for $t_{LS} \geq \tau_2$

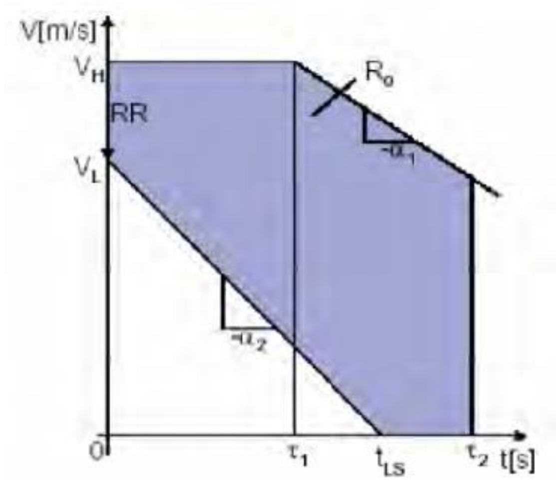

Figure 4: Interpretation of Honda Algorithm for $t_{LS} < \tau_2$

5. Results

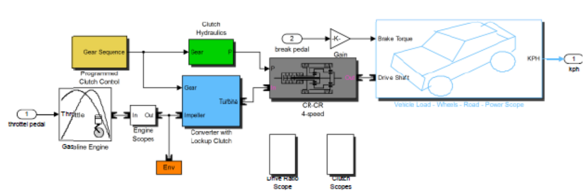

Figure 5: SIMULINK Model of Car

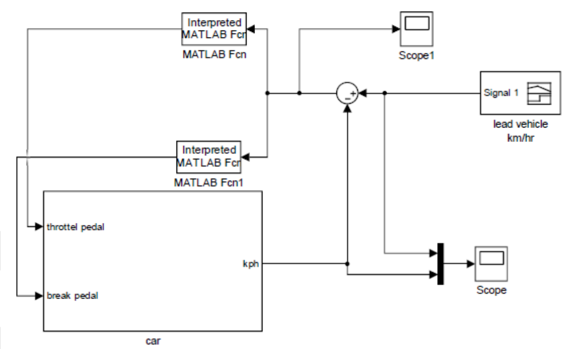

Figure 6: SIMULINK Model with Neural Network

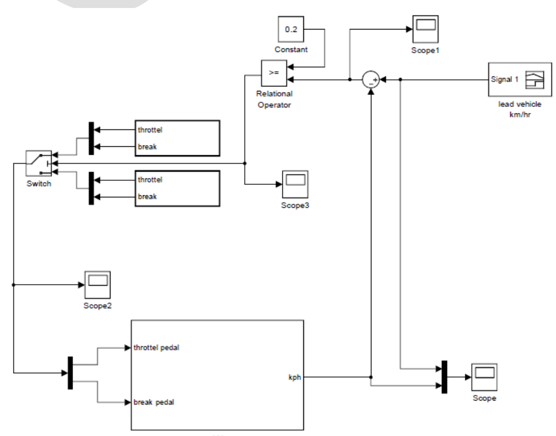

Figure 7: SIMULINK Model with Honda Algorithm

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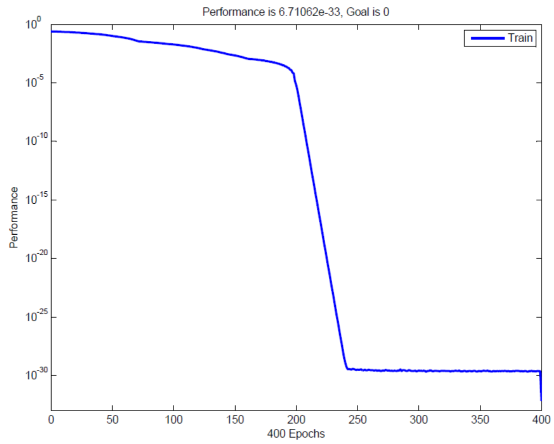

Figure 8: Neural Network Training

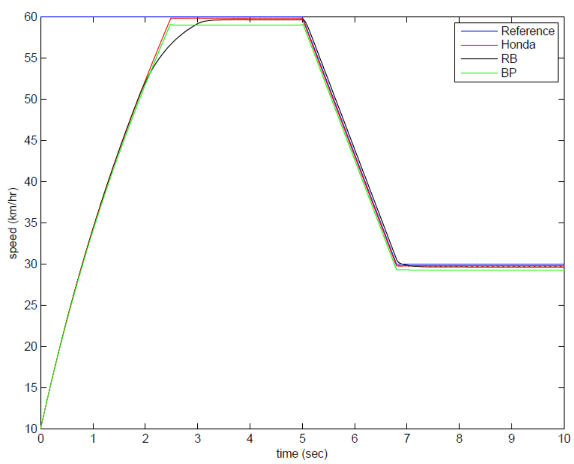

Figure 9: Speed Response graphs for various algorithms

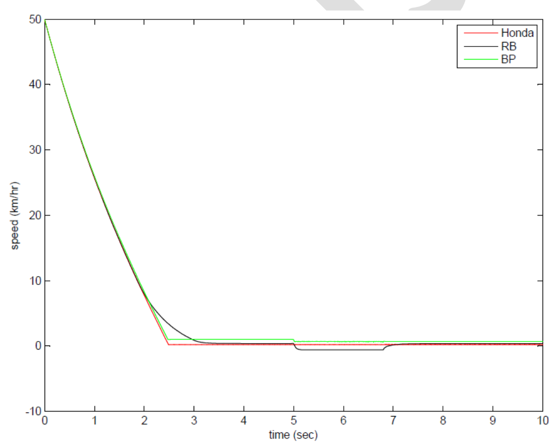

Figure 10: Error Response graphs for various algorithms

6. CONCLUSION

The traffic volume and cars performance are evolving on a fast scale. The human capability to cope with the accidental prone situations is subjected to particulars realization and expertise of driving. In such situations the automated methods are mandatory to be installed in transportation units that could control a car based and minimize the probability of accident. While most of the security features halts a car upon sensing collision probability, anti cruise system controls the speed of car throughout the time and regulates it according with speed of car in front. Thus the car under test, keeps the continuous motion that benefits the traffic. In comparisons with Honda Algorithm and BP and RB Neural Networks, the Honda Algorithm managed the car speed in efficient manner in comparison with NN. The algorithm was tested for two cars where the system was deployed in rear car. The results demonstrate the effectiveness of proposed architecture. However, looking into more generalized scenario of automated transportation, systems limitations to speed could be enhanced to direction and intelligent traffic sensing. The scenarios of overtaking, indicators action, automatic darkness sensor, sensing of driver's consciousness are many independent sectors that could be elaborated in near future.

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