ABS Functionality Along with the Pressure Control

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Abstract - *During the hard braking, the vehicle may go uncontrollable that causes a slip and also it effects the performance of the system. There are many primary braking system but the Anti-lock Braking System always plays a major role in the automotive industries. The ABS prevents the locking of the wheel that keeps the vehicle stable and steerable. Harder the brake, there is a shift in the vehicle's weight from the rear wheels to the front wheels called Pitch. The sudden brake and pitching in the vehicle increases the pressure inside the ABS. As a result, it effects the ABS system. The PCA (Pre-Control Actions) strategies along with ABS functionality is utilized.*

Key Words: **Antilock Braking System (ABS), Wheel Slip, Deceleration, Control Factor, Target Pressure.**

1. INTRODUCTION

Electronically monitored slowing mechanism (ABS) keep brakes from locking during braking. In ordinary braking circumstance the driver control the brakes, anyway during cuts off braking or on dangerous roadways when the wheels to approach lockup, the antilock comes into picture [1]. The ABS regulates the brake line weight free of the pedal power to take the wheel speed back to the slip level range that important to the ideal braking execution. The ABS does not permit full wheel lock under braking. In straightforward terms, during crisis of braking, the wheel does not get locked even on the off chance that you push a full auto brake pedal and thus the sliding does not happens. It enabled driver to control the vehicle simpler, even on streets with low adhesion, such a rain, snow and muddy road. The brain of Antilock braking system comprise of Electronic Control Unit (ECU), wheel speed sensor and hydraulic modulator [4]. ABS depends on the various factors i.e. Wheel deceleration, Wheel slip and different road conditions.

This paper is organized as follows. A brief introduction is given in section 1, section 2 discusses the literature survey, section 3 addresses an Overview of the Proposed Scheme, section 4 discusses the System Design. Section 5 addresses the steps of Implementation followed by conclusion and future work in section 6.

2. LITERATURE SURVEY

This is the opening paragraph to the work which explains different papers and projects. A review is given on how the braking system is developed from the past years and how it is tested in the different road conditions. All the referred papers which exposes about ABS and its

components and how it is helping in the stopping distance, the detection of the various road condition and how the reduce stopping time, limit slip ratio improves the performance controlling system (reducing rise time and overshoot) on the ABS brake is described.

In this paper, exposes about ABS and its components and how it is helping in the stopping distance. Antilock Braking System (ABS) is utilized in the automobiles to prevent the slip and locking of wheel after brake. It is car wellbeing framework, the controller is given to control the fundamental torque to keep up ideal slip proportion. The slip ration signify as far as vehicle speed and wheel turn. It's a automated framework that kept running on standards of threshold braking and rhythm braking which were polished by apt drivers with past age stopping mechanism. It reaction time is extremely quicker with the goal that makes simple controlling for the driver. ABS for the most part offer propelled vehicle control and limit the ceasing separation in elusive and dry surface, on the other hand on free surface like rock or snow secured asphalt, ABS can altogether expand braking separation, also improving vehicle control [6].

In this paper, how the rough road is detected using the suspension information system is described. Direct detecting of rough road conditions are utilized to alter task of a wheel slip control framework. In any event one suspension sensor detects a working parameter of the suspension framework. A road surface classifier is receptive to the suspension sensor for producing a road surface sign speaking to a harshness of a road surface over which the vehicle voyages. ABS system incorporates a wheel speed sensor and a brake actuator. A functioning braking control identifier wheel slip in light of the wheel speed sensor during at any rate one of braking or quickening of the vehicle and balances the brake actuator because of the distinguished wheel slip. The dynamic braking control is receptive to the road surface sign for altering balance of the brake actuator as a component of the road surface sign [2].

In this paper, proposed how the Antilock brakes give the capacity to shorter stopping distance and the capacity to steer and keep up control during hard braking, particularly on wet and slippery surfaces. Variations in the values of weight, the friction coefficient of the road, road inclination and other nonlinear dynamics may exceptionally influence the presentation of stopping automations (ABS). In this paper, fuzzy self-tuning PID controllers with utilizing ANFIS have been improved in stopping automation. This controller planned with three

control destinations comprise of reduce stopping time, limit slip proportion and improve the exhibition controlling system on the ABS brake [5].

In this survey paper, different technologies and algorithm used for execution of Anti Lock Braking System (ABS) is described. The ABS is made more efficient and reliable. Arduino is used for developing a prototype and to test the reliability and efficiency. An overview of the previous ABS work is also discussed [8].

3. AN OVERVIEW OF THE PROPOSED SCHEME

In the proposed work, the Pre-control Actions (PCA) strategies are the part of the ABS system. The PCA prevents the negative spike brake apply for the start of the ABS on the high mue.

The goal of the undertaking is to overcome the following aspects. Negative Effects of spike brake apply (weight) could prompt greater braking distance (~ 1m) caused due to:

1) a solid pitching of the vehicle body.

2) the steep pressure increment before the start the of ABS which leads to the low performance.
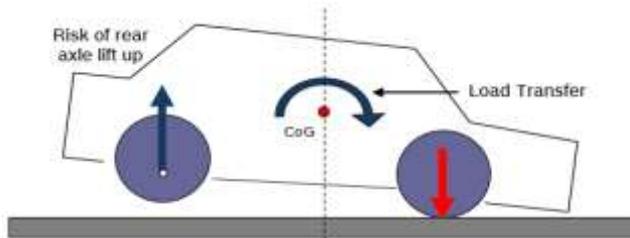

Fig.1: Pitching of the vehicle body

Load Transfer from rear to Front Dependent on wheel deceleration, mass, gravity and wheel base.

Vehicle Pitch is observed due to:

* Weight transfer from rear to front when high speed braking is applied on high mue.

* Pressure buildup at Front wheels

* Pressure release at Rear wheels ABS active (slip > slip threshold and a wheel + offset)

Weight Tansfer
$$= \frac{\text{aWhl} * \text{Center of mass height} * \text{Total vehicle mass}}{\text{gravity} * \text{wheel base}}$$

Braking at 100kph on high mue could result into vehicle pitching behavior as shown in the Figure 1 if the steep brake pressure is not controlled and thus brake performance could be affected.

4. SYSTEM DESIGN

Since the ABS is already having a existing architecture, [4] need to make the required modifications for the diagram. The figure 2 shows the old design in which pressure increase is calculated with feed forward control in the old design and steep pressure increase was controlled by 1.5 bars every cycle. There was no smooth transition between PCA and ABS. If PCA is active at one of the rear/front wheel, the ABS was overwriting the PCA [7]. As a result pressure was decreasing suddenly. This could effects the performance of the ABS system. The pressure control is taken care in the new design along with the ABS.
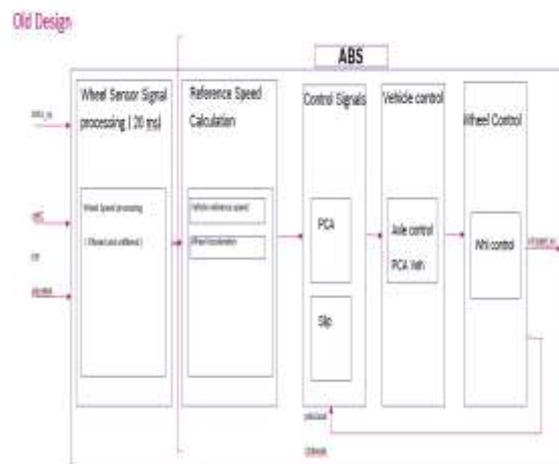

Fig.2: The Old Design

The figure 3 shows the new design, the pressure increase, decrease and hold is taken care. On high mue, high speed braking, steep pressure can lead to pitching of the vehicle. Pressure increase design is made robust by introducing feedback controller to:

* Control steep pressure increase

* Allows smooth transition from PCA to ABS states

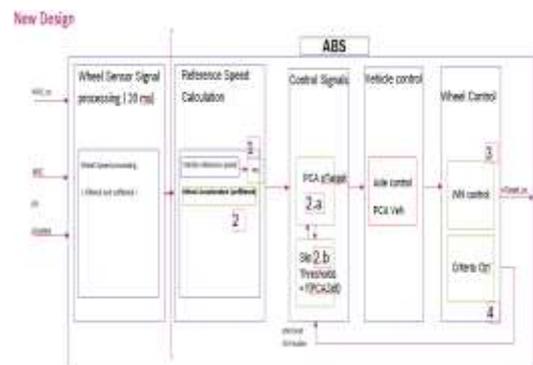* Saves application tuning effort for the vehicle pitch model.

Fig.2: The New Design

5. IMPLEMENTATION

The implementation in the SDLC means the coding had to be done for the each specific requirement. The PCA strategy is carried out in the four steps, in which the control factor plays a major role. The control factor is implemented in such a way that steep pressure increase is smoothened. The four steps that are necessary for this work are Slip calculation of PCA reference speed, Control factor calculations, Reference speed adaptation calculation and PCA to ABS Transition are described. The variables like slip, wheel deceleration, target pressure and control factor plays an important role. The four implementation steps are explained below.

- **Slip calculation:** Slip is a relative motion between the wheel tire and road surface [3]. The formula for calculating the slip is
$$\frac{Vehicle\ speed - Wheel\ Speed}{Vehicle\ Speed}$$

- **Control Factor Calculation:** Based on the Wheel deceleration, PCA time and Slip percentage, the control factor is decided between -1 to 3. The formula used for the control factor calculation is:
$$Ctrl_{Factor_x} = aWhl_{Tgt}.\,getAt * (PCA\ time - a\_Rad\_x) * aWhl2Fac$$

- **Reference Speed Adaptation calculation:** The Pressure Target Increment is calculated as:
$$pTargetIncrement = \left(PreControl_{Increment} * \left(1 + Ctrl_{Factor_{xy}}\right)\right)$$

  The PreControl Increment is nothing but the pressure increment which is dependent on the factors like PCA Time and Pressure Gradient.

  PreControl Increment
  $= Pressure$ Increment as f(PCA Time, pMC gradient)

- **PCA to ABS Transition:** The ABS was overwriting the PCA which is active in the FL&FR of the wheel axle. As a result the pressure will suddenly decrease as the ABS is active. This is taken care based on the pitch.

6. CONCLUSION AND FUTURE SCOPE

The plot from the tool is verified and validated and it is observed that when the slip is inside the threshold i.e. in between 10% and 20% of slip then only the Pre-control Increment is detected. For the PCA the ESDL class is verified instead of the functionality. The verification is done by doing the Unit Testing and the code coverage is observed as 95%. For the pTarget Increment also the output is verified by doing the Component Testing. The overall functionality of pTarget Increment had been verified and validated by checking the plot from the CT and observed that the rough road is detected only when the

wheel deceleration is in the range of -30m/s2 to -10 m/s2.

In this work, the pressure control is made only for the ABS system. For the other components like VDC, TCS etc can be considered as the future work.

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