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Analytical Study Of The Preposed Advanced Combined Antilock Braking System

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Abstract: *Electronically Controlled Combined-ABS is a novel controlled braking system for motor vehicles. The present review is a part of analytical & numerical study that categorically involves intrinsic survey of ABS. In this present manuscript the authors limit themselves in scholastic analysis of the design of C-ABS systems only. Furthermore, MATLAB simulation tool is employed to prototype a cognizant model and a comparative study is followed then after. This happens to be a heuristic approach and it is exclusively relevant to a generic crisis. The authors advocate for the incorporation of electronically combined antilock-braking systems in future motorcycles.*

Keywords: *C-ABS, Electronically Controlled Unit (ECU), Enhanced Safety with precise braking mechanism.*

I. INTRODUCTION

Combined Anti-lock braking system (C-ABS) is an automobile safety system which allows the wheels of a motor vehicle to maintain tractive contact with the road's surface electronically according to driver's inputs while braking, preventing the wheels from locking up and avoiding skidding. It also offers precise vehicle control and decreases the stopping distance on any kind of road condition. In contrast to conventional systems, electronically Controlled Combined ABS features are pivotal as it delivers precise control of brake fluid pressure that helps to prevent wheel lock. As a result, system minimizes the vibration of the vehicle eliminating brake lever pulsing for better, smooth ABS performance and braking.

II. NATURE OF PROBLEM

No of two wheelers is increasing day by day and so do accidents too. Most of these accidents in motorcycles are caused due to skidding.

Table: 1

YEAR	ALL VEHICLES	TWO WHEELERS	CARS, JEEPS, ETC.	BUSES, ETC	GOODS, ETC.	OTHERS
2009	114951	82402	12313	1486	6041	9710
2010	127746	91598	17109	1527	6432	11080
2011	141866	101865	19231	1604	7064	12102
2012	159491	115419	21568	1677	7658	13169

Table 1 is a generic conception of the increasing no. Of vehicles & Table 2 shows the fragility in the increasing of the numbers of accidents. Here, with respect to the tabulated data it is clear that with each passing year the number of vehicles is increasing rapidly.

Table:2

YEAR	NO OF ACCIDENTS
2008	484,704
2009	486384
2010	499628
2011	497686

It is observed that the no of accidents is almost 5 lakhs every year. Thus safety is the only solution for all accidents, reasons of the accidents are many but we must minimise.

Table 3 is a recorded fatality of deaths owing to road accidents.

Table: 3

YEAR	NO OF ROAD ACCIDENTS	NO OF FATAL ACCIDENTS	NO OF PERSONS KILLED
2009	10900	19766	19728
2010	119024	22846	24616
2011	118089	24137	27290
2012	122968	26002	28022

The tabulated data is a clarity of the relevance of the accidents & it depicts that the major part is caused due to two wheelers, so it is a point of concern for us to minimise this by any means of safety and other possible ways.

III. FEW STUDIED PROBABILITIES

The authors intend to reduce the stopping distance & gain more enhanced but skidding free braking experiences. Here, the road surface type and conditions can be taken from the vehicle's braking pressure, wheel slip measurements, and deceleration rate is to be accounted. The wheel slip is regulated spontaneously to get the maximum road adhesion. By keeping all of the wheels of a vehicle near the maximum friction coefficient an optimal solution can be achieved. A combined antilock system will attain maximum fictional force as reported in journals of repute [4]. This mechanism results to the minimization of the vehicle stopping distance.

Simultaneously emphasis is given to increase Stability. A locked-up wheel generates reduced braking force, lesser than the peak value of the adhesion between the tires and the road. Additionally it will also lose its capability to sustain any lateral force. This results in the loss of vehicle stability and many times causes accident. C-ABS system on the other hand is to prevent any wheel from locking up and to keep the longitudinal slip in an operational range by combining the braking pressure equally in both the wheels.

Furthermore, the additional concern is to increase the Steerability. Good peak frictional force control is necessary in order to achieve satisfactory lateral forces and, therefore, satisfactory steer-ability. If an obstacle appears without warning, emergency braking may not be sufficient as when the wheels are locked up, motorcycle no longer responds to the driver’s steering intention and thus it skids. Again C-ABS, if is omnipresent then the vehicle remains steerable during emergency braking, thus the obstacle can be avoided safely.

IV. EMPIRICAL STUDY OF THE COMPONENTS OF C-ABS

The compromising of C-ABS are documented for analytical perusal -

Electronic control unit (ECU).It receives signals from the sensors in the circuit and controls the brake pressure at the road wheels according to the data analysed. The ECU assists vehicle operator to prevent wheel lockup by regulating wheel slip. Periodically hydraulic control unit or modulator receives operating signals from the ECU to apply or release the brakes under ABS conditions. It executes the commands using 3 solenoid valves connected in series with the master cylinder and the brake circuits. The one valve for front wheel hydraulic circuit, and one for rear wheel. Thus brakes can be actuated by controlling hydraulic pressure. Power booster and master cylinder assembly is one critical element as when the driver pushes the brake, the master cylinder transforms the applied force on the pedal into hydraulic pressure which is thrusted simultaneously to both the wheels. It enacts as soon as power assistance is implied during braking. Last but not the least is the wheel sensor unit. Speed sensors are simply of a magnet induced in coil and a toothed sensor ring. Cumulatively an electrical field given off by the contact between the magnet and the toothed ring creates an AC voltage. It mimics the backlash controlling phenomenon & widens the magnetic hysteresis. The voltage frequency is directly proportional to the wheel's rotational speed. It monitors the rotational speed of the wheel and transmits this data to the C-ABS control module.

V. MODOUS OF PERANDI OF C-ABS

If a wheel-speed sensor signals a lock up - the ECU sends a current to the hydraulic unit. This intrinsically energizes the solenoid valve. The action initiates the valve isolation steadily, the brake circuit from the master cylinder is detached. Eventually this stops the braking pressure at that wheel from rising, and keeps it constant. It allows wheel velocity to increase and slip to decrease. When the velocity increases, ECU re-applies the brake pressure to restrict the wheel slip to a particular value. Hydraulic control unit controls the brake pressure in each wheel cylinder based on the inputs from the system sensor. This consequently controls the wheel speed. This is envisioned in subsequent sections.

VI. OPERATIONAL MONVERER OF THE PROPOSED COMBINED ANTILOCK-BRAKE SYSTEM

Usually under braking, if one or more of a vehicle's wheels lock (begins to skid) then few dire consequences occurs:-
a) Braking distance increases,
b) Steering control is lost (skidding takes place)
c) Tire wear will be abnormal.

The obvious consequence is that an accident is far more likely to occur. The application of brakes generates a force that impedes a vehicles motion by applying a force in the opposite direction. During severe braking scenarios, a point is obtained in which the tangential velocity of the tire surface and the velocity on road surface are not the same such that an optimal slip which corresponds to the maximum friction is obtained. The C-ABS controller must deal with the brake dynamics and the wheel dynamics as a whole plant. The wheel slip, S is defined as:

$S=(V-\omega R)/V$--------------------*(i)*

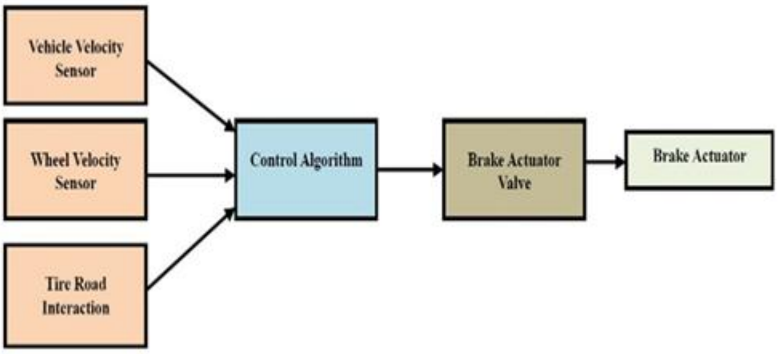


Fig 1: Block diagram of braking system.

Where ω, R and V denote the wheel angular velocity, the wheel rolling radius, and the vehicle forward velocity, respectively. In normal driving conditions, $V = \omega R$, therefore $S = 0$. In severe braking, it is common to have $\omega = 0$ while $S = 1$, which is called wheel lockup. Wheel lockup is undesirable since it prolongs the stopping distance and causes the loss of direction control.

VII. EMPIRICAL MODELLING OF ANTILOCK

Wheel slip: When the braking action is initiated, a slippage between the tire and the contacted road surface will occur, which make the speed of the vehicle to be different from that of the tire.

The longitudinal slip is defined as:-

$S= (V\cos\alpha-\omega R_w)/V\cos\alpha$----------*(ii)*

The side slip angle is:-

$\alpha=\tan-1*(V_{sy}/V_x)$----------*(iii)*

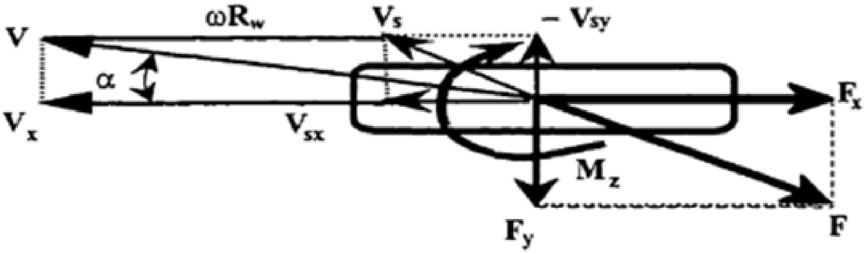


Fig 2: Force and velocity components on tyre.

According to Newton's second law, the equation of motion of the simplified vehicle can be expressed by,

$m_tV =-F_t-F_a$----------*(iv)*

The road friction force is given by Coulomb law

$F_t=\mu N$----------*(v)*

The total mass of the quarter vehicle can be written as

$m_t=m_{tire}+m_c4$----------*(vi)*

Thus, the total normal load cm be expressed by

$N=mtg-FlFl$---------*(vii)*

is the longitudinal weight transfer load due to braking.
Following Fig3 portrays the artefact of vehicle dynamics.

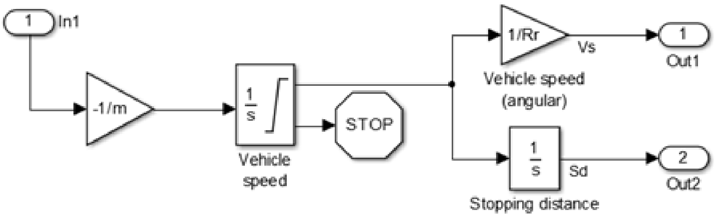


Fig 3: Simulink model for vehicle dynamics

The same Newton's second law states that, the equation of motion at wheel level for the rotational DOF is given by,

$Jw\omega=-Tb+FtRw$----------*(viii)*

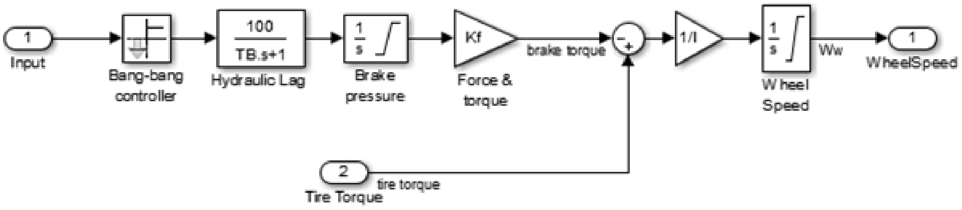


Fig 4: Simulink model for wheel dynamics

The above fig is a heuristic modelling of wheel dynamics.

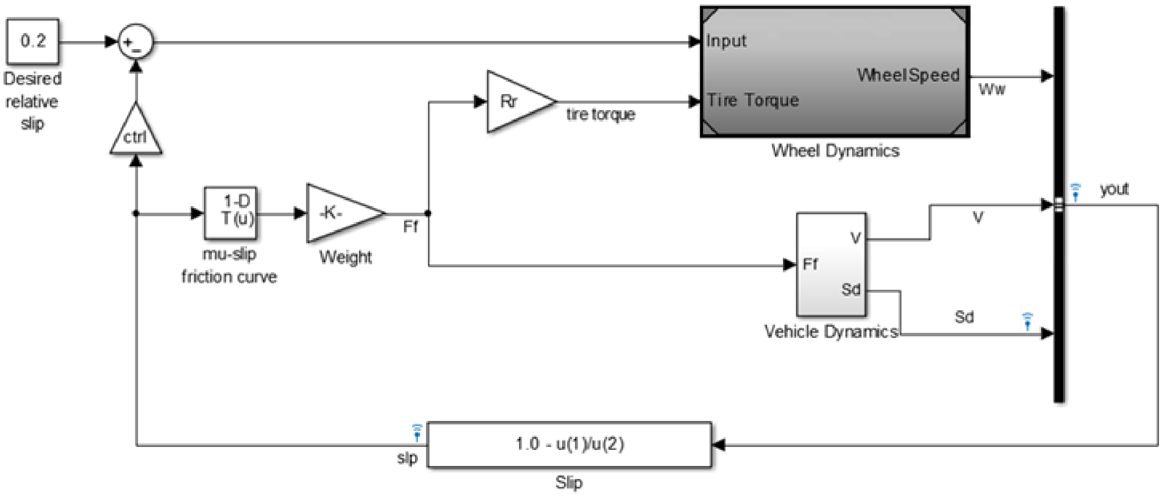


Fig 5: Modelling of an Antilock Braking System

Assumption: Only a linear model was considered and does not include actual road conditions. The system here is modelled only for straight line braking.

Gravitational constant g=32.18 $ft/s2$ Initial velocity of vehicle $v0$=88 ft/s Wheel Radius Rr=1.25 ft Mass of vehicle m=50 lbs Maximum Braking Torque $Tbmax$=1500 $lbf*ft$ Hydraulic Lag TB= 0.01 s Moment of Inertia Jw=5 $ft4$

VIII. RESULTS

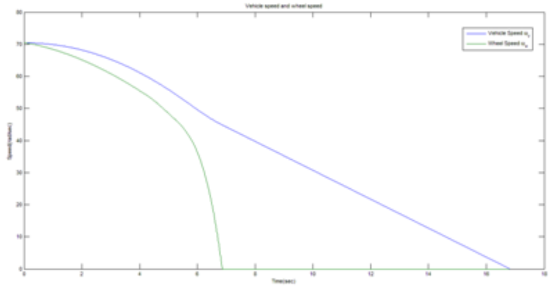


Fig5:- VEHICLE SPEED AND WHEEL SPEED (WITHOUT C-ABS)

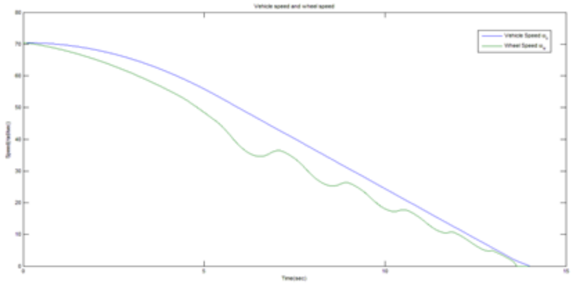
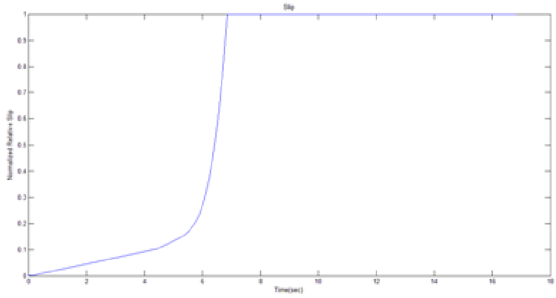


Fig 6: VEHICLE SPEED ANDWHEEL SPEED (WITH C-ABS)



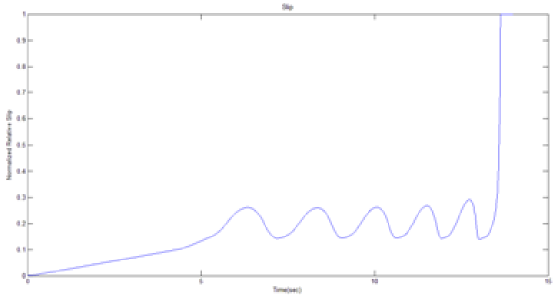
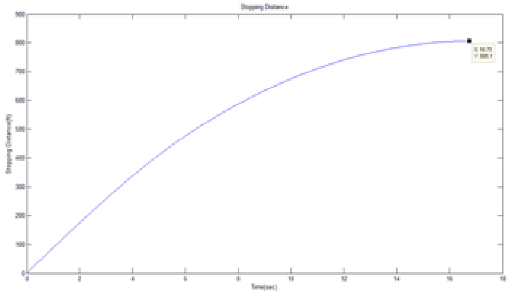


Fig 7: SLIP (WITHOUT C-ABS) **Fig 8:** SLIP (WITH C-ABS)



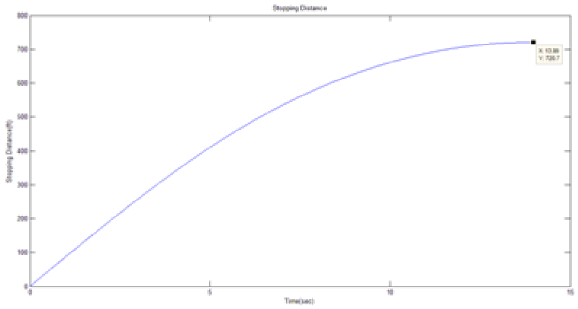


Fig 9: STOPPING DISTANCE (WITHOUT C-ABS)

Fig 10: STOPPING DISTANCE (WITH C-ABS)

IX. CONCLUSION

Ample study revealed that C-ABS is highly nonlinear due to its complicated relationship between its components and parameters. Thus it is quite fascinating but challenging endeavour. This research that has been carried out in C-ABS control systems covers a broad range of issues and challenges. Most of these approaches require system models, and some of them cannot achieve satisfactory performance under the changes of various road conditions. A brief idea of how soft computing is employed in C-ABS control is given; It is inferred that C-ABS improves the braking performance, the stopping distance after using C-ABS system has considerably reduced, C-ABS can achieve more stability than other conventional braking systems, it provides enhanced driver safety on any kind of road conditions. Moreover intelligent combined braking technology is likely to be incorporated widely in future bikes and automotives.

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