Review on Antilock Braking System

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Abstract: Now a day, Antilock braking system is used in the various vehicles. This system increases the efficiency of the car and at the time of shorter stopping distance allowing steering control and increases the steering ability. It consists of parts like speed sensor like optical encoder for calculating motion of Wheel, electronic control unit, toothed wheel, hydraulic control unit, brake pedal, master cylinder, etc. This braking system is useful for both disc brake and drum brake according to part used in the system. In this there are almost ten research papers summary is taken for understanding antilock braking system working and the new invention takes place in system. Also the working of ABS with the disc and drum brake with the different Simulink model and flow charts. It explained in well manner.

Keywords: Antilock braking system, speed sensor. Valve, controller.

I. Introduction

The brake system is the most important part in the any vehicle. Antilock braking system is the antiskid braking method. This prevents the vehicle from locking up and decreases the stopping distance. ABS system uses the principle method of threshold braking. There are various advantages of antilock braking system like increased stopping power, improves traction control and steering ability.

There are five major components used in the antilock braking system. ABS speed sensor, valve, brake fluid, pump, controller.

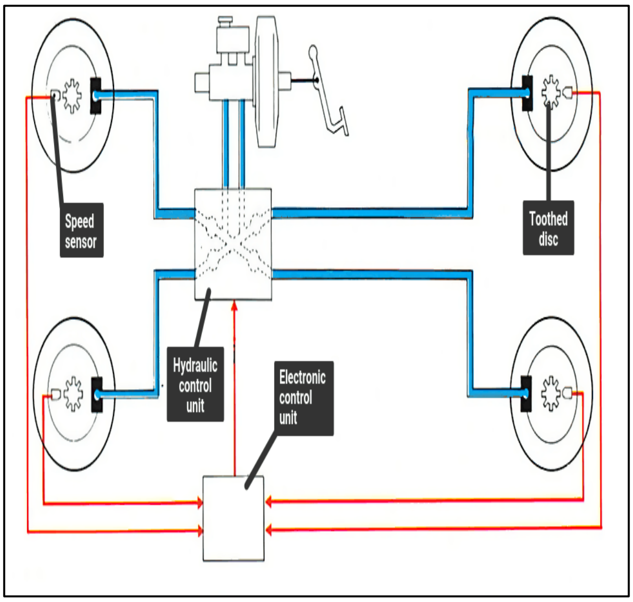

Figure 1: Brake Circuit Diagram

(i) Speed Sensor:

Speed Sensor in the ABS system is used to calculate the rotation of the toothed wheel and this signal is transferred to the electronic control unit and according to that braking action is performed.

(ii) Valve:

Valve is the very important part in the circuit. It makes closing and opening actions through the master cylinder when brakes are applied. There are 3 positions in this condition.

- In open position, the brake fluid is flowing through the circuit.
- In block position, blocking of extra pressure in the circuit takes place
- In release position, there is no pressure acting in the brake circuit .

(iii) Pump:

The pump in the ABS is used to store pressure in the hydraulic brake lines after valves are released.

(iv) Brake Fluid:

Brake fluid is the main component in the hydraulic brake circuit. The creates pressure after applying the force on brake fluid. Mostly brake fluid with high boiling points are used in brake circuit.

(v) Controller:

Controllers are used to receive the information from each speed sensor and according to that brake action takes place in the circuit.

II. Literature Review

[1] Dynamic Coordinated Control for Regenerative Braking System and Antilock Braking System for Electrified Vehicles under Emergency Conditions by Yang Yang, Qingsong Tang, Li Bolin, and Chunyun Fu. In this paper, they have used the method of threshold control along with the phase plane theory for taking analysis of the slip rate and braking torque in the ABS braking process to obtain the proper braking. Based on Regenerative braking system and Anti-lock braking System is proposed to increase the efficiency of braking energy. This paper is useful for ABS and RBS development in electric vehicle.

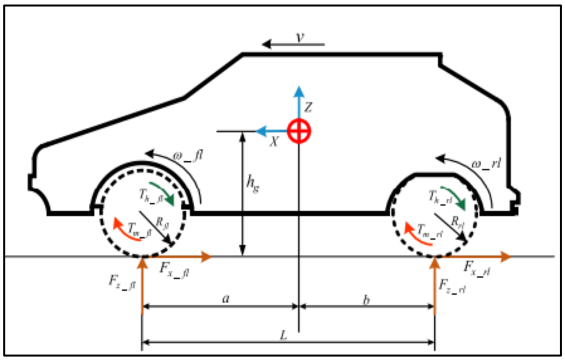

Figure 2: Free body Diagram

In the Fig.2 free body diagram specifications are
m = mass of the vehicle
v= Wheel Velocity
hg = Height of centre of gravity

This paper is taking the analysis in between slip rate and braking torque when ABS brakes are applied and also it's obtains the composition rule of braking torque which is important for ABS braking. Along with this traditional strategy and proposed strategy are used to simulate emergency braking conditions on the roads which having different adhesion coefficients. This method is used to decrease the stopping distance and stopping time and by using this braking performance increases.

[2] Fixed Time Slip Control with Extended State Observer using only wheel speed for Anti-Lock Braking Systems of Electric Vehicle by Sesun You, Jeonghwan Gil, and Wonhee Kim. In this research paper, they proposed fixed-time slip along with the ESO. The ESO is used to wheel speed, tire-road friction and slip generator is designed which provides desired slip in real time applications. The simulation is done in the MATLAB/SIMULINK software and by using these decreases the stopping distance and stopping time.

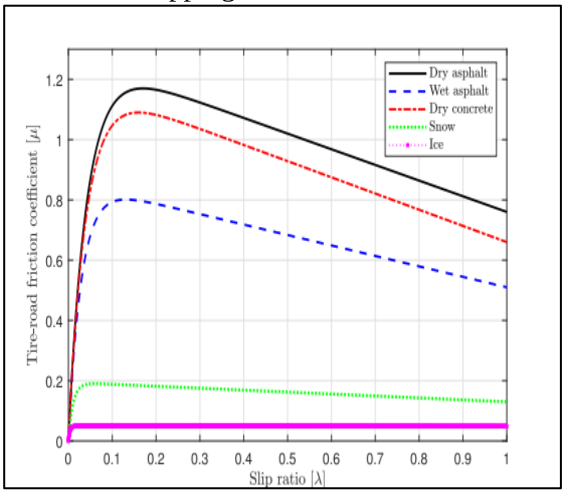

Figure 3: Slip Ratio vs TFC

The above graph is about different road conditions slip ratio and TFC (Tire-road Friction Coefficient). Friction coefficient changes according to slip ratio are shown and best is for dry asphalt road.

In this study, they presented the fixed time slip along with ESO for an electric vehicle's ABS utilising simply wheel speed feedback. The longitudinal speed, tire-road friction, and wheel speed are all projected by the ESO. The ideal intended slip was calculated in actual time based on the projected longitudinal tire-road friction and the state of the road. For the purpose of ensuring the upper certain of time, the fixed-time controller was created. Three situations were simulated on the jump road, the split road condition, and the rapidly cornering jump road to evaluate the performance of the suggested strategy. CarSim and MATLAB/Simulink were used to carry out these simulations. It was discovered that the ESO estimates the real states. To increase the longitudinal friction between the tyre and the road, the ideal desired slip was generated. As a result, the proposed technique outperformed the traditional ABS in terms of ABS braking performance. Furthermore, the proposed approach's braking distance and time were much shorter than those of the conventional ABS method.

[3] Optimal Anti-Lock Braking Control with Nonlinear Variable Voltage Charging Scheme for an Electric Vehicle by Jun-Cheng Wang, Ren He, and Young-Bae Kim Member. In this paper, for vehicle safety in difficult braking conditions an effective ABS brake control method for an electric vehicle is used. To reach optimum energy recovery and to equilibrium the energy differences of each battery cell used in the system during anti-lock braking, a variable voltage charging control strategy method is very useful. In order to supply the best hydraulic pressure for the ABS system, an ideal sliding mode anti-lock braking control strategy is created. This torque is calculated as one of the disturbance vectors by using the non-linear voltage charging control rule. In this way, the hydraulic brake torque compensation control replaces the torque allocation process. The efficiency of the suggested best anti-lock braking control system with improved energy efficiency is supported by simulation findings.

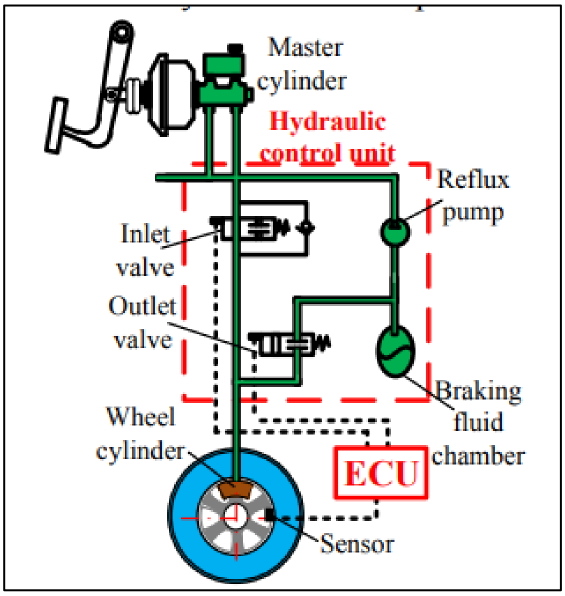

Figure 4: ABS Diagram

The above diagram is of ABS system which contains different parts like master cylinder, hydraulic control unit, electric control unit, inlet valve, outlet valve, speed sensor, etc.

The suggested nonlinear VVCC law is used to develop an ABS system technique that is different from torque allocation in order to maximise energy recovery under the presumption of car safety. First, the models for an electrical vehicle's longitudinal wheel rotation dynamics using speed sensors, hydraulic control ABS, and regenerative braking system are built to achieve accurate braking torque of the regenerative braking system, the steps of the VVCC methods are suggested. The results show that difference between SM-ABS controller, the root mean square error for slip ratio for different roads like dry asphalt, frozen asphalt and different roads lowers by 36.46%, 38.39%, and 31.65%, respectively. Additionally, the OSM-ABS system produces the efficiency of 5.34%, 14.62%, and 5.98% of kinetic energy for electric vehicles of three braking conditions.

[4] Quasi-Sliding Mode Control With Orthogonal Endocrine Neural Network-Based Estimator Applied in Anti-Lock Braking System by Stanisa Lj. Peri c, Dragan S. Anti c, Miroslav B. Milovanovic, Darko B. Miti ´ c, Marko T. Milojkovic, and Sa ´ sa S. Nikoli ˇ c . In this paper, In this study, a novel control technique for nonlinear discrete-time systems is presented. Output model that utilises both neural networks and a quasi-sliding mode. Initially, an input-output. It is described how to control discrete time quasi-sliding mode using an inserted integrator to further reduce babbling. Various nonlinearities exist because of these factors, including. Considering the uncertainties, the controlled object's model described sufficiently. These flaws in modelling result in a modelling inaccuracy and a pretty subpar system performance. To improve the accuracy at steady state condition, an projected value of the modelling error of the following into the control law. In order to do this, we suggest two upgraded structures of the utilising the implementing the These activities have already demonstrated their efficacy as a tool for modelling, identification, and signal approximation. dynamical system analysis, synthesis, and simulation. Finally, using an anti-lock braking system is a sample of the analysed class of vehicles, real-time tests and digital simulations are used to validate the suggested strategy. mechatronic systems, in a lab setting. The efficiency of the suggested technique in terms of improved steady state conditions is confirmed by a detailed study of the results.

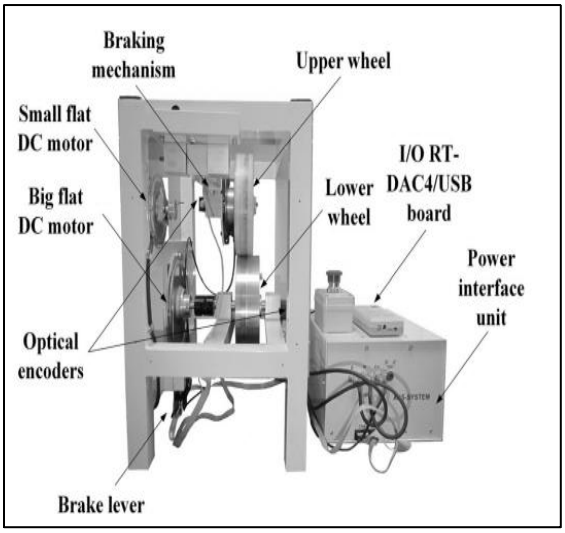

Figure 5: Laboratory ABS Setup

An orthogonal quasi-sliding method control is used for a kind of nonlinear systems, an estimator based on endocrine neural networks is proposed. Here, the babbling is reduced by placing the numerical integrator in front of the control law's relay. Due to the system's current nonlinearities, we presented a method to improve steady-state accuracy. An orthogonal endocrine neural network-based estimate of modelling error. In order to do this, we presented two distinct orthogonal endocrine neural network topologies. through the use of generalised quasi-orthogonal functions in a certain layer. The defaulting functions, which are executed in the neurons of fourth layer, are changed in the existing ANFIS structure in favour of generalised quasi orthogonal functions. The proposed structure allows the dynamic system to even after the training procedure is through, the environment changes as a result of the stimuli given. A new structure made up of a layer GQOENN and NARX linkage was used to predict the modelling error. Generalized quasi orthogonal basis functions of the special type and weights of this model are used to approximate the neuron functions. external stimuli were introduced and altered the structure. The computation time was greatly shortened as a result of the simplified structure. On an actual ABS, the proposed control algorithm was evaluated. as one of the mechanical systems with the aforementioned nonlinearities, and the outcomes are thoroughly examined. There have demonstrated that the suggested technique results in superior system responses. The results demonstrated that the proposed structure had reduced error and quicker computation times, which were crucial for controller’s design. Of course, higher complexity and cost accompany better controller performance on the negative side. This is the cause. why this control algorithm should only be employed in situations where doing so is appropriate, as when it increases human safety, as in this essay.

[5] Four-Wheel Anti-Lock Braking System with Robust Adaptation Under Complex Road Conditions by Jinhong Sun, Xiangdang Xue, Senior Member, IEEE, and K. W. E. Cheng. In this paper, antilock braking system is developed using wheel slip control. The four wheel drive and wheel slip control technology. This study introduces the fuzzy mode control approach for ABS. Contrary to the majority of single-wheel ABS, this method gives more accuracy in critical road conditions like traditional roads, split road conditions and also extreme road conditions where each wheel condition is different. Additionally, the proposed tire-road interaction (TRI) model's nonlinear function was based on the road condition checking module gives information on the different braking conditions features that are necessary for the ABS to function. Simulink's model of the car and tyre is created using the BYD F0 vehicle specifications. By using MATLAB and RT-LAB different road conditions are checked.

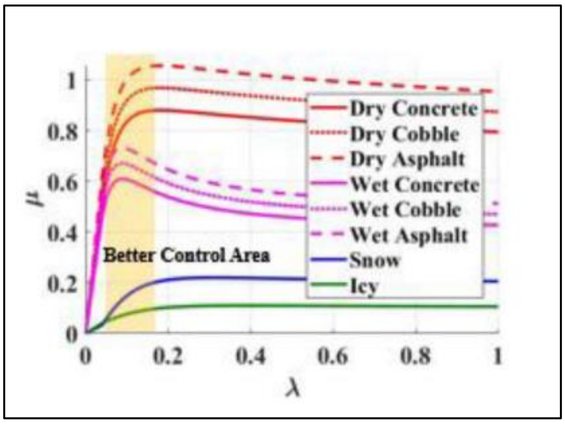

Figure 6: μ − λ curve

The FSM-WSC based ABS system controller for the 4-wheel car or any vehicle is proposed in this paper, and performance of simulation is checked using different road conditions. Additionally, the controller module offers reliable and quick ABS management and automatic road condition detection module serves the second module's operational foundation. Together, these modules have a significant capacity to handle difficult braking circumstances. The simulation results under complicated driving conditions have validated the suggested four-wheel ABS's robustness, improved self-adaptation, and quicker reaction.

[6] Research on Anti-Lock Braking Control Strategy of Distributed-Driven Electric Vehicle by Deliyang yu, Wensong Wang, Huibo Zang, Dongyu Xu. In this paper, by using different braking conditions analysis is taken in this paper and also the recovery of regenerative braking system energy. To take the analysis of braking conditions a single wheel braking model is used and different forces are calculated on that model and slip rate calculation is also done. In the MATLAB and CARCISM software model is developed, the combined simulation is run. The simulation grades demonstrate that the investigated control approach can reliably predict and regulate the ideal slip rate under a variety of different road conditions, achieve the protection and stability of electric vehicle braking control.

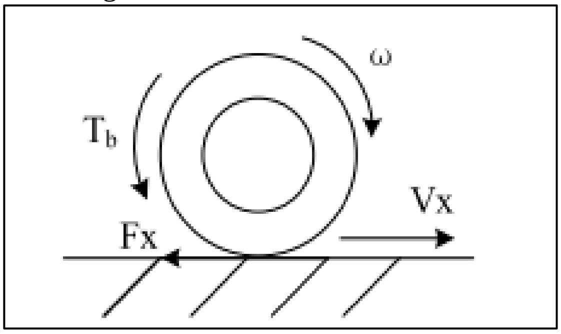

Figure 7: The signal wheel rotating model of a car.

There are forces shown in the Fig. (7) are

Fx = Frictional force between tire and road.

Vx = Velocity of wheel.

Tb = Torque acting on the wheel.

ω = Angular velocity

In MATLAB and other software, simulations of various road conditions are run. The outcomes of the simulation demonstrate the capabilities of the control system envisioned in this article to maintain the vehicle's constancy during emergency braking conditions.

[7] Uncertainty estimation based approach to anti-lock braking systems by Adarsh Patil1 , Divyesh Ginoya, P. D. Shendge, Member, S. B. Phadke. In the Fig. 9 ABS setup free body diagram is shown. Upper wheel is showing tire of the vehicle and lower wheel shows the road. The setup works in two phases accelerating and braking phase. The frictional force acting in the

tire and road is µFn for braking system. There are also various components like brake lever, optimal encoder, braking motor and pulley are used for setup development.
Also slip ratio verses coefficient of friction graph is generated as a output. First, coefficient of friction is increases upto when slip ratio is 0.2 and the decreases.

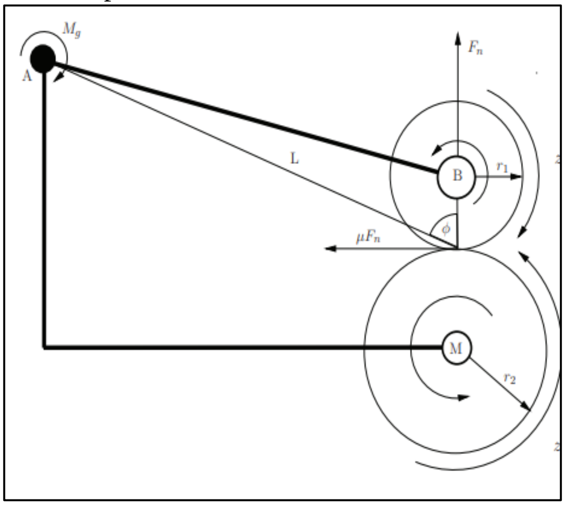

Figure 8: Free body diagram of ABS Setup

For anti-lock braking systems, two solutions based on the uncertainty estimation are proposed. Even if it is believed that no information of the boundaries of uncertainties and disorders, including the road grip adhesion, friction coefficient, exists, the methods are effective in controlling the slip ratio. The findings of the simulation and testing confirmed the suggested strategies. A comparison of the strategies with the well-known bang-bang control method shows that they may be able to lessen the shock that the driver feels. There is still need for improvement in the evaluation of the proposed systems' applicability to split-surfaces. There are three methods are used for analysis of simulation that are bang-bang controller method, IDC based backstepping controller method and IDO based SMC method.

[8] Realization of Anti-Lock Braking Strategy for Electric Scooters by Weng-Ching Lin, Chun-Liang Lin, Senior Member, IEEE, Ping-Min Hsu, and Meng-Tzong Wu. In this paper, In this study, regenerative braking system, kinetic energy, and short-circuit braking mechanisms are used to create a nontechnical antilock braking system controller for electric scooters. In which the ideal slip ratio between tyres and road surface is guaranteed by a boundary layer speed control. Combining with this controller, the antilock braking controller makes either an open-circuit or a short-circuit loop on the motor stator's coil load, producing braking effects similar to the traditional Antilock Braking System control. Practical realisation of the projected ABS controller. Through real-world experiments, the issue of enhancing the braking performance for the ABS action is further talked.

Figure 9: Testing of ABS with Scooter

This research investigates a ABS control scheme for the ESs with two wheel. Details on the creation of the control plan and the hardware execution are offered. We demonstrate that it is possible to provide Antilock Braking System control for ESs that perform similarly to those with gas engines, but with far greater braking torque spreading flexibility and responsiveness to anti-block braking. The proposed idea for ES brake control performs satisfactorily according to well-conducted real-world trial results.

[9] Adaptive Estimation of Vehicle Velocity From Updated Dynamic Model for Control of Anti-Lock Braking System by Sadra Rafatnia and Mehdi Mirzaei. In this paper, the primary difficulty in creating the automotive Anti-lock braking system control systems are to contact a trustworthy model due to the unknowns and variations in tyre forces and vehicle dynamics. The initial in this article's The dynamic vehicle braking system model is efficient at utilising estimate of the model's terms at each moment a fresh prediction strategy. The suggested estimating technique employs as a guide the (GNSS) to often and adaptively estimate the vehicle's speed if the acceleration sensor's bias is changeable. The A mathematical analysis of the proposed estimate procedure is performed. experimentally tested to demonstrate its excellent accuracy simply changing parameter settings. In order to prevent the tyre from locking, a nonlinear controller based on the projected active model is created. This controller tracks the required slip. The control system is evaluated using the CarSim programme as a platform for virtual vehicle experiments. The collected findings show that, when compared to the typical sensor-based ABS controllers, the suggested control system increases braking performance.

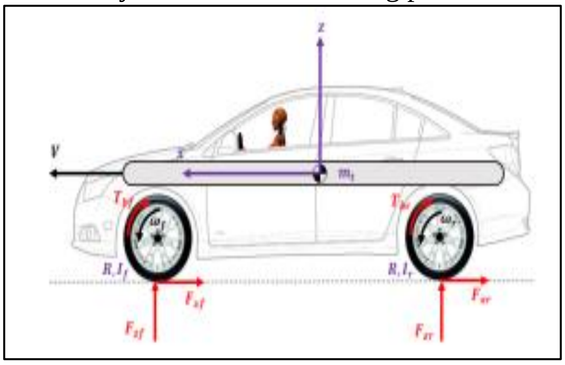

Figure 10: Two wheel vehicle model

By changing the vehicle dynamics online, the consistency of the model-built controller is no longer an issue. through the suggested estimation algorithm. Additionally, the partiality of the accelerometer, a measuring uncertainty, is adaptive projected. Software in the loop simulation using the CarSim has verified the suggested estimation algorithm. environment.

[10] The fuzzy robust cooperative control of the vehicle steering/anti-lock brake system by Guo Li, Zebin Feng and Xu Wang. In this paper, in order to construct a new supportive model of the vehicle for the steering ABS stability areas, a new cooperative error was first defined. It was suggested to use a two-level unclear robust cooperative controller system. The performance layer and the cooperation layer made up the architecture. The performance layer's moment and front wheel angle with strong controllers were created based on the desired control index to improve the vehicle's response, robustness, and stability because the uncertain parameters reduce system performance. The strong anti-lock brake controller for vehicles was created. A novel useful cooperative control law was developed in the cooperation layer, based on robustness and the optimum index. The fuzzy control method was invented in order to get rid of controller conservation. After that, the braking force distribution strategy appropriate for the challenging work environment was provided.

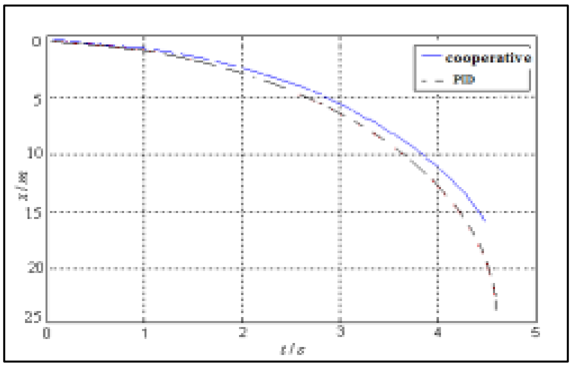

Figure 11: Stopping Distance

In this paper, a double-layer cooperative system made up of an performance layer and a direction level was designed with a focus on the steering anti-lock braking system control fields of the vehicle. The results of the simulations under various conditions gives comparison between two systems.

III. Conclusion

In this paper, we have done the review of the ten research paper. There are different conditions of ABS used are verified using these papers. Different parts and working of the ABS system is explained. Also different conditions for various types roads are explained. Regenerative braking system explanation with antilock braking system also explained.

IV. Acknowledgement

We would like to express our gratitude to our college professors who guided us throughout the project. Our team members gave valuable suggestion from time to time which helped us in completing this project. We would also like to thank all the authors of the research papers because of whom we were able to expand our knowledge which was required for this project.

V. References

[1] "Dynamic Coordinated Control for Regenerative Braking System and Antilock Braking System for Electrified Vehicles under Emergency Conditions'' Yang Yang, Qingsong Tang, Li Bolin, and Chunyun Fu.

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