ANTILOCK BRAKING SYSTEM BASED PID CONTROLLER

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A report submitted in fulfilment of the requirements for the degree of the Bachelor of Mechanical Engineering.

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DECLARATION

I declare that this project report entitled "Anti-lock Braking System based PID Controller" is the result of my own work except as cited in the references.

Signature:……..……………………………………

Name : Mohd Izzat Izzuddin bin Mohd Nasir

Date : 19/6/2021

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive).

Signature :.....................................

Supervisor's name:.....................................

Date :.....................................

DEDICATION

This study is wholeheartedly dedicated to my family, who have been my source and inspiration and gave me strength when I felt thought of giving up, who continually provide their moral, spiritual and emotional.

To my friends and classmates who always give me advice and moral word to me to encouragement to finish this study.

ACKNOWLEGMENT

Throughout the writing of this project, I want to grateful to Allah S.W.T on completing this undergraduate project.

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ABSTRACT

The current study focused on the development and validating of the quarter vehicle model in order to evaluate the dynamic vehicle behaviours of the Antilock-Braking System (ABS). The simulation vehicle model was developed in the MATLAB Simulink software with all the parameters. Vehicle velocity, wheel speed and longitudinal slip was include in the vehicle dynamics behaviour at the quarter of the vehicle. In his project, the comparison between the experimental and simulation with the sudden braking were made for the validation. In this validation, it can say that, the experimental and simulation was similar and identical with the acceptable error. In addition, the comparison of simulation between ABS and non-ABS was made and the stopping distance reduction also was made.

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CHAPTER 1

INTRODUCTION

1.1 Background.

Based on the experience of auto manufacture, there have been many accidents that claim the lives of consumers each year. As a result, automobile engineers conducted an investigation and strengthened the protection mechanism in the manufacturing of vehicles before they were launched. According to one of the analyses, the cause of the accident is a braking system problem. This braking system is a vital component or system in any car, where the brake systems act as a mechanism to regulate the speed and stop the vehicle, especially when an emergency brake or sudden brake is applied. This braking mechanism must provide a powerful braking force to stop a car, and the distance from the downturn to breaking the vehicle is also significant to the user when breaking the vehicle. However, car users lack a thorough understanding of how to better bribe the vehicle when abrupt brakes are applied.

In order to continue the development of the automotive technology, to ensure safety of the passengers and driver, automotive engineers repaired this braking system. Such types of brake systems have been developed, including disc brakes, drum brakes, hydraulic single circuit breaks, hydraulic dual circuit breaks, brake-by-wire, ABS (ABS), electronic wedge brakes and other brakes (EWB). Each of these types of braking has strengths and weaknesses. However, according to research, the use of an antilock braking mechanism (ABS) is more effective than other forms of brakes. ABS is a safety device to avoid the tire from locking during braking circumstances occur in an emergency or at abrupt. When this happen which is emergency brake, the possibility to loss traction is high between the tire and surface of the road. This situation can call tires skid as the tire loss grip or traction on the road surface. As a result of ABS studies, several different types of controls have been created. Proportional Integral Derivative (PID) is a control strategy that has been introduced by automotive experts today. The main focus of this study is an Antilock Braking System-based Proportional Integral Derivative controller. The Simulink will be used to control the braking mechanism in this project.

1.2 Problem statement.

Nowadays, antilock braking system has been install in many vehicle as the braking system for the safety factor. Day by day, as the automotive technology development, the antilock braking system also improved. In this antilock braking system, there are many strategic controls and have some weakness which can be analysed based on the research that has been done by the previous researchers. Therefore, to reduce the stopping distance and to manipulate slip wheel ratio to reach the maximum friction when the sudden brake was applied, the antilock braking system based on the proportional, integral derivation was used the vehicle which is very efficient based on the previous study.

1.3 Objectives.

The objectives of this project are as follows:

1. To validate and modelling the quarter vehicle model with the braking test.

2. To investigate the performance of braking system of the antilock braking system based on the proportional integral derivation.
3. To do the comparison of the results simulation between with and without ABS which is reduction of the stopping distance.

1.4 Scope of Project.

1. In this study, will be focuses the antilock braking system based proportional integral derivation as the controller.
2. The desired results of the braking system are simulated. It is inspired by the ABS demo model, employing the programming, simulation and analysis from MATLAB Simulink Software.
3. The comparison between the performance antilock braking system based proportional integral derivation with the previous study will be done.

1.5 General Methodology.

The action that need to be carried out in order to achieve the objectives in this project are listed below in the flow chart of the methodology. Also, the table below show the Gantt chart of the PSM 1. However, more methodology details that will provide in the Chapter 3.

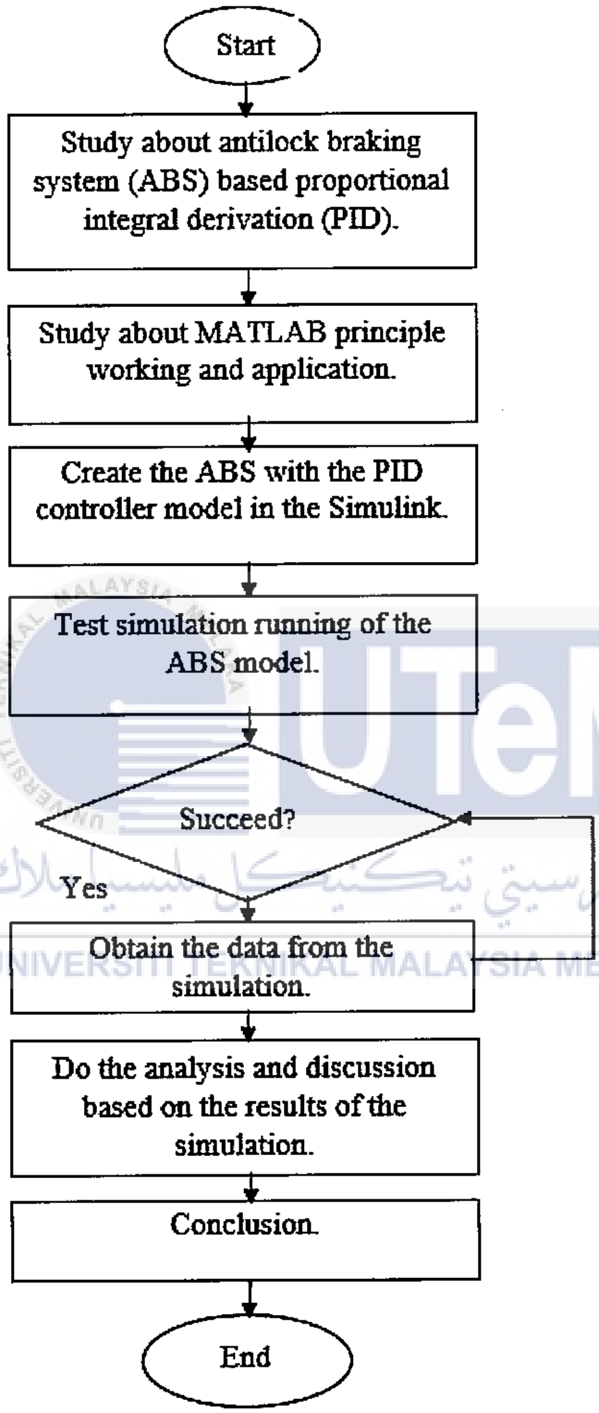

Figure 1.1: Flow chart general methodology.

Table 1.1: Gantt Chart for PSM I

WEEKS / ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Project briefing	■	■												
Determine the objective, problem statement, and scope of this project	■	■	■	■	■									
Literature review	■	■	■	■	■	MIDSEM BREAK	■	■	■	■	■	■		
Submission progress report PSM I							■	■	■	■	■			
Create Simulink diagram									■	■	■			
Report writing												■	■	
Report submission													■	
PSM I seminar														■

Table 1.2: Gantt Chart for PSM II

WEEKS / ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Continue create Simulink diagram.														
Trial run the Simulink diagram														
Analysis and discussion									MIDSEM					
Submission progress report PSM II									BREAK					
Report writing														
Report submission														
PSM II seminar														

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

This article clarifies briefly the basic idea of automobile braking and the categorization of the kind of braking system, the braking system theory, and so on. Afterwards, the existing braking limit in traditional cars was discussed. After that, the ABS development is explained and it also contains the proportional integral derivative ABS controller (PID).

2.2 Brake categories.

A mechanical device that slows movement is a braking mechanism. Often utilised in rotating axles or wheels, the braking system may also be used in other forms, such a fluid surface used in water or in air flaps. Braking may typically be split into several sections, such as pumping frequencies, electromagnetic breaks and friction frequencies, based on special use (Owen, 2011). A braking system for pumps is a design in which a pump already forms part of the device. This characteristic is usually found in the internal combustion engine, where a combustion piston motor may halt the supply of fuel (Porter and Semer, 1975).

Furthermore, the current break mechanism is an electromagnetic breaker that is known as the current brake mechanism. In the case of hybrid powered cars and trains, this braking is employed extensively to charge the batteries using the electric moctor. This brake system is known as a regenerative braking system, because the braking process produces electricity (Xu et al., 2011, Yoong et al., 2010). The popular breaker used today for many applications is the frictional force, where an explicit wear surface may be employed in shoes or pad frequencies. An air and hydrodynamic brake is also a friction brake where a workable fluid and air are used to transfer the braking force. However the word frictional brake is often known as the pad-break, except the break for hydrodynamics yet the same working theory applies. (Owen, 2011, Limpert, 2011).

2.3 Conventional Brake Technology.

The early friction braking devices for use in automobiles were horse carts and horses which is the only source of resistance. Not only did the animals speed up but they also slowed down and absolutely stopped the car. Later, the use of steel rimmed wheels started on a truck, and the vehicle was halted by mechanical equipment. As can be seen in Figure 2.1, there is just a woodblock and a lever framework in the mechanical braking process. The driver had to pull the lever next to him and turn the wooden block on the wheel while the car stopped (Limpert, 2011). The system has proven to be effective in both horse and steam-powered vehicles.

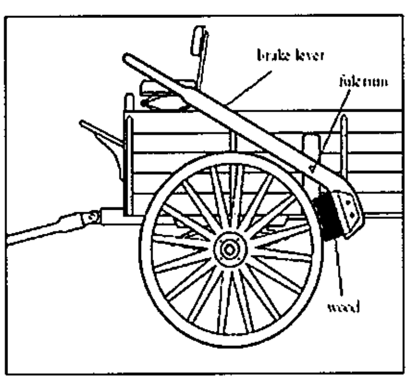

Figure 2.1: Wooden lever brake system (D-Brake,2012).

The braking system is hypothetically inadequate to slow down a vehicle when motor vehicle evolves continuously. It is no longer efficient since heavy cars enable a higher power required by the driver to stop the car weight. By the end of the 1890's, when the Michelin brothers began to replace the rubber tires with steel rimmed spokes, they became obsolete. Of course, the wood block framework was ineffective when mixed with rubber (D-Brake,2012).

2.3.1 Drum brake.

Drum brakes, in general, are brakes that use friction created by a series of pads that push against a spinning drum-shaped component known as a brake drum. Thus, the lining radially pushes against the inner surface of the drum when the driver brake is applied. This causes friction that slows or inhibits wheel and axle rotation. (Kushal & Sharma, 2015). On the other hand, the vehicle, have hydraulic braking systems, which are more effective than mechanical braking systems. The brake pedal, master cylinder, hydraulic fluid, switch tubes, and vacuum servo are the key components of this machine. There are two types of hydraulic brakes based on the configuration of actuators: drum brakes and disc brakes (Moseley and Mikhail, 2013)

In keeping with the continuous rising development of automobile technology, drum brakes were employed to replace human excitement on a vehicles by the internal combustion engine. The drum brake provided certain advantages with the hand lever over the push brakes. Most of them were that water and gravel could be kept away by the drum. These pollutants weaken the disc breaks in the open. The bigger benefit was that drivers were able to exert lower pedal pressure compared to disc brakes using drum brakes (Breuer and Dausend, 2003). This was particularly significant in the days before hydraulic and power breaking systems, which decreased the necessary pedal pressure.

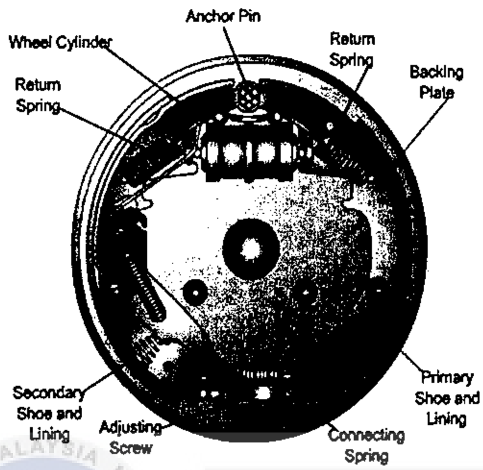

Figure 2.2: Drum brake (Study Guide, 2004).

In this mechanical braking system, there are now several failures. The fact that the car loses stability and forces users to put a huge amount of effort on the brake pedal to decelerate the vehicles, cannot split all the wheels in equality. By the invention of the hydraulic braking system, car mechanics achieved significant progress in 1918 in brake technology. (Limpert, 2011).

2.3.2 Disc Brake.

Frederick William Lanchester originally developed the hydraulic discs in the Birmingham plant in 1902, using the first hydraulic discs in the Lanchester automotive sector in the years 1906 to 1914. They were limited to usage up to the 1950s since they needed additional pedals to function efficiently (Limpert, 2011). The increased pedal pressure is due to the fact that there is no self-service or self-energy potential of the drum brakes. By the forward movement of the automobile, the self-serving effect is generated. This forward movement helps to put the drum in touch with the brake shoe. This contributed to reducing the pedal pressure. The easiest way to do this was by multiplying the force of the brake pedal by the hydraulic break system, the disc brakes.

Chrysler was the first to integrate the disc brake in their trucks in general from the beginning of the 1950s. The approach has not been advanced. It would appear that the braking pressure needed by the driver was already a bit too high to gain widespread market adoption, therefore reducing it. The struggling Studebaker manufacturer had to reinstall the device in 1964. It was increasingly popular in this age and in a few of years disc brakes were standard on most new automobiles. The higher efficiency braking mechanism was one of the reasons why the disc brakes were manufactured by Studebaker instead of Chrysler. In the 1950s, power stops became popular following Chrysler's construction and maintenance of the disc frequency programme. The system helped to move the piston in the master cylinder and the driver needed less pedal pressures to get the same braking force. The adoption of the stronger disc brake became popular since it was no longer an issue for easy breaking.

The disc brakes usually include a rotor, a disc that rotates in conjunction with a wheel and a square installed on the anchoring plate or bracket of the suspension system. The hydraulic piston converts a pressing force within the calliper to the hydraulic pressure and provides the necessary frictional force to stop. Only two kinds of disc brakes are available, the floating and fixed types of calliper. The floating form of the calliper may be floated sideways on its support. On either side of the calliper, is the hydraulic lines connected and the movement is crossed by the calliper on the other side A calliper with hydraulic line on the two pistons on both sides of the calliper describes the kind of a fixed calliper (Mahmoud, 2005).

2.3.3 Disadvantages of Drum Brake.

- Lower braking efficiency, when the friction material characteristics might alter during heating.
- Driver pressure must push the brake-pedal further, because of the heat expansion, the diameter of the drum rises significantly.

2.3.4 Disadvantages of Disc Brake.

- Have lower sensitivity to brake fade but they are more expensive and have lower brake effectiveness (Mahmoud, 2005).
- With disc brake, the brake fluid pipe is typically exposed. If this brake fluid pipe damaged, the brake will fail and can results in a dangerous situation.

Even though have disadvantages, this brake type still important in the vehicle nowadays because factor of safety. In order to improve the factor of safety for the passengers and driver, in automotive development, brake-by-wire (BBW) system was used.

2.4 Brake-by –wire Technology.

This shows that standard modern braking system's fundamental technology, including all hydraulic parts such as the booster, master cylinder, and hydraulic, is being replaced by high-speed electronics. Therefore, this brake-by-wire technology have its own advantages such as:

- It reacts rapidly, resulting in shorter stopping distances, and it is also concerned with factor safety.
- This brake by wire technology has a brake assist system that operates on speed.

- This mechanism is connected with antilock brakes, and since mechanical parts are unavailable, this brake by wire system does not produce vibration from the brake pedal.
- Reduce the total weight of the machine, thus boosting fuel efficiency.

There are 3 generally electro-hydraulic brew (EHB), electric-pneumatic break (EPB) and electromechanical brake systems in the three brake-by-wire categories (EMB)(Mamilla & Mallikarjun, 2009).

2.4.1 Electro-hydraulic Brake (EHB).

In contrast to the operation of a standard braking system, when pressing the brake pedal with EHB, the necessary order is electronically sent to the hydraulic unit's electronic controller. As a result, this defines the maximum stopping strength and hydraulically activates the brake callipers (Mamilla & Mallikarjun, 2009).

2.4.2 Electro-pneumatic Brake (EPB).

The EPB is a braking system that employs modern technologies to provide electronic braking in addition to the existing pneumatic braking mechanism. Initially, simulation and field trials of this braking system demonstrated the system's capabilities to significantly minimise stopping distance and in-train forces, increase train handling, and provide simultaneous braking power (Prasania and Saradava, 2012). EPB is the solution method for vehicles that do not have a properly dimensioned on-board network for dry EMB on all four wheels (Mamilla & Mallikarjun, 2009).

2.4.3 Electro-Mechanical Brake (EMB).

Two versions of brake-by-wire with disc-brake callipers are now available and they are distinguished by their driving mode. The rest keeps current hydraulic breaks inside an updated electrical hydraulic system while one system utilises electromechanical brakes. Because only a change in a current system is required, electrical hydraulic brakes are regarded as the first braking system approach. Electrohydraulic brake systems have higher brake pressure resolution than standard hydraulic systems with proportional valves. The other feature that influences the braking performance is that the actuator can produce and dissipate brake pressure at the calliper. Hydraulic methods often work well in high load situations, but electromechanical breaks that have a high resolution of the clamping force levels and have the possibility for high frequency and release rates provide an alternative.

2.5 Antilock Braking System (ABS).

Antilock Braking System (ABS) is a mechanism that prevents the wheels from being static even though the brake pedal is completely depressed. As a result, drivers may operate the car normally and manage it to prevent collisions or other malfunctions. Antilock braking systems, also known as active braking systems, were first introduced in aircraft technologies to reduce stopping time. In 1978, the S-class Mercedes was the first car to use ABS. This antilock braking technology is mainly used in the automobile industry nowadays. ABS is an electronic braking system that is used to shorten stopping distances and prevent wheel slip, especially during emergency braking (Antic et al., 2010).

The brakes are applied and released in a second for multiple times, so that wheels do not lock under heavy braking. When ABS works, the car will therefore slow down and keep the tyres on the road surface. The existing traction can also provide the driver with the steering input to manage the car and prevent the collision. ABS is made up of four components:

- Wheel-speed sensor: A speed sensor's role is to determine the acceleration or deceleration of the wheel. The ring and the magnet contact produces an electric field. This signal will then be converted into a digital signal and delivered to the Electronic Control Unit ABS controller (ECU).
- Controller: The controller is a kind ECU unit in the automobile that collects information from every single wheel speed sensor; or else the signal will be transmitted to the controller if the wheel loses its attraction.
- Hydraulic Pressure Modulator: The pump is employed in ABS systems to restore pressure on the hydraulic brakes after valves release the valve and when wheel slips are detected, a signal from the controller releases a valve.
- Valves: This feature controls the pressure amount. The valve system is the most problematic when the valve is clogged. The mechanism is expected by activating the valves and managing the pressure supplied to the brakes when the loaded valve is incapacitated to open, shut and change position.

While there is no appropriate sensor that can correctly determine the ground of the road and makes this accessible to the ABS controller in this system, sensors continuously receive input on braking force. Because of the strong braking, the wheel will lock up and the controller in the central electronic unit will send signals to the hydraulic system, forcing the electro-