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Brake Failure Detecting and Alerting System in Cars

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CHAPTER NO.01

INTRODUCTION

A Brake Failure Detecting and Alerting System in cars is an advanced automotive safety mechanism designed to continuously monitor the condition and performance of a vehicle's braking system and warn the driver in case of any malfunction. Since brakes are one of the most critical components for vehicle safety, even a minor fault such as low brake fluid, hydraulic leakage can lead to serious accidents. This system uses various sensors, including brake fluid level sensors and hydraulic pressure gauge to collect real-time data about brake performance. The data collected by ultrasonic sensor is transmitted to arduino, which detects abnormalities or unsafe conditions. If any irregularity is found, the system immediately alerts the driver through dashboard warning lights, audible alarms, or digital display messages. By providing early detection and timely warnings, the Brake Failure Detecting and Alerting System helps prevent accidents, reduces maintenance costs, and ensures safer driving conditions. Overall, the Brake Failure Detecting and Alerting System enhances vehicle reliability, improves driver awareness, supports preventive maintenance, and plays a crucial role in ensuring road safety by minimizing the chances of unexpected brake malfunction.

Brakes are one of the most critical safety components in any vehicle. Failures can occur due to:

- Low brake fluid levels in reservoir.
- Hydraulic leakage in brake lines.

1.1. Problem Statement:

Our problem is that we don't have brake failure indication system in automobile, so to overcome the brake failure we have to do:

1) Brake failure is one of the major causes of road accidents.

2) Sudden loss of braking can lead to serious injuries, death, and property damage.

3) Brake issues such as low brake fluid, hydraulic pressure drop are often not detected early.

4) Existing systems like Anti-lock Braking System (ABS) prevent wheel locking but do not always provide early warning of brake failure.

5) Many vehicles do not have a real-time brake health monitoring system.

6) Drivers may not realize brake problems until braking efficiency is reduced.

7) Lack of early detection increases accident risk, especially at high speeds.

8) There is a need for a cost-effective and reliable system to monitor brake conditions continuously.

9) The system should detect faults in real time and alert the driver immediately.

10) The solution should be easy to install and suitable for different types of cars.

1.2. Objective:

The main objective of this project is to avoid accidents due to brake failure. The specific objectives of this project were:

1. To design an Automobile Hydraulic Brake Failure Indicator with auxiliary for a drum brake system.
2. For continuous monitoring of hydraulic braking system.
3. For the protection of the driver & passengers.
4. System will give audio-visual indicator when there is leakage of oil in brake lines or low brake fluid in the oil reservoir.
5. To avoid road accidents due to failure of brake.

CHAPTER NO.2

LITERATURE SURVEY

Project is fully equipped and designed for safety of the automobile vehicles. Automatic Hydraulic brake failure indicator and alerting system is the most effective solution to this problem. It is the most effective and the simplest methodology used to reduce the rate of accident due to brake failure.

In this system, if Hydraulic brake failure is occurred then the buzzer gives the indication to the driver in the form of sound and simultaneously alternative braking system start their working and apply the secondary brakes by using motor fitted to the chassis, as the result of these the speed of the vehicle gets reduced and vehicle is stop in some second.

The main advantage of the system is that it is compact in size, and the installation cost is very less. If this system is installed in vehicle, then accident due to brake failure gets reduced, as the result of these the rate of accident due to brake failure get reduces.

K.Mohan1 and G.Pugazhendhi Department of Mechanical Engineering, IFET College of Engineering, Villupuram, Tamilnadu, India. Article Received: 07 June 2017 Article Accepted: 27 June 2017 Article Published: 01 July 2017 had conclude that project is fully equipped and designed for safety of the automobile vehicles. Automatic brake failure indicator and braking system is the most effective solution to this problem. In this system the components used are two-way relay, buzzer, battery, motor, wiring system. And finally, the braking system installed in the two-wheeler by using these components the most effective system is to be generate. In this system, if brake failure is occurred then the buzzer gives the indication to the driver in the form of sound and simultaneously alternative braking system start their working and apply the secondary brakes by using motor fitted to the chassis, as the result of these the speed of the vehicle gets reduced and vehicle is stop in some second.

Dr.N.Venkatachalapathi1, V. Mallikarjuna2 Professor and Head1, Assistant Professor2 Department of Mechanical Engineering, Annamacharya Institute of Technology & Science, Rajampet, and A.P – India has founded that an Automatic Brake Failure Indicator and Over Heating Alarm The braking system of a car is undoubtedly one of its more important features. The aim of this work is to create a better braking system with indicator. Brake failure occurs only because of worn out of brake shoe and cut in liner. It consists of two sensors. One sensor is connected with the brake shoe. The other sensor is the brake liner. The signal from the two sensors is given to a microcontroller. When the brake shoe is worn out, the sensor senses signal to the microcontroller. Also, if the brake liner is cut, the sensor sends

signal to the microcontroller. The microcontroller analyses the signal and operates the corresponding indicator. It nothing wrong, the vehicle will move and if any one critical, the vehicle will stop and the screen shows the indication of brake failure. Since this indicates the status of the brake, the user can identify the condition of the brake and thus limiting the chances of malfunction.

G.Venkata Siva and eta 1PG Research Scholar, Product design, Mechanical Engineering, JNTUA College of Engineering, Ananthapuramu, and Andhra Pradesh had been concluded that an Automobile Brake Failure Indicator The auxiliary braking unit is used as secondary braking unit when the primary hydraulic disc brake of the vehicle fails. The secondary brakes receive power from battery. The secondary braking unit is a hub motor unit present at both the wheels of the rear axle. The hub motor also called as wheel hub drive is an electric motor incorporated into the wheels of the vehicle. Hub motors have their highest torque when they start. When the relay receives positive value from comparator, it connects the power source to the hub motor .The hub motor rotates in a direction opposite to the direction of rotation of the wheels. Therefore the hub motor provides negative torque to the wheels and retards the output power of the wheels.

Vishal Pagar and eta Automatic Brake Fluid Leakage Prevention with Safety Bypass Braking System-2018 Automatic break failure indicator and auxiliary braking system is consisting of pressure differential sensor circuit, control unit and frame. The sensor is used to detect the brake fluid line, the control signal to the braking valve unit.

The purpose of this literature review is to understand existing braking system available which can avoid road accidents due to brake failure.

CHAPTER NO.3

SCOPE OF THE PROJECT

A Brake Failure Detecting & Alerting System is an advanced safety solution designed to monitor the braking system in real-time, detect potential failures, and alert the driver immediately to prevent accidents. The scope of this project can be explained under the following areas:

1. Safety Enhancement

The system aims to improve vehicle safety by detecting early signs of brake malfunction before complete failure occurs. It reduces accident risk caused by brake fluid leakage, pressure loss, or worn-out brake pads.

2. Real-Time Monitoring

The project continuously monitors critical brake parameters such as hydraulic pressure, brake fluid level, and pedal force. Unlike traditional systems such as the Anti-lock Braking System, which prevent wheel locking, this system focuses on early fault detection and warning.

3. Multi-Sensor Integration

The project includes integration of multiple sensors:

- Fluid pressure sensors for hydraulic failure detection due to fluid leakage.
- Fluid level sensors for brake fluid monitoring.

This provides comprehensive brake health monitoring rather than single-parameter detection.

4. Embedded System Design

The system uses microcontrollers (Arduino) for:

- Signal processing.
- Threshold comparison.
- Fault detection.
- Alert generation.

This gives strong scope in embedded programming and circuit design.

5. Driver Alerting

The system provides:

- Dashboard warning display
- LED indicators
- Buzzer alarm

This ensures immediate driver awareness during brake malfunction.

6. Application Scope

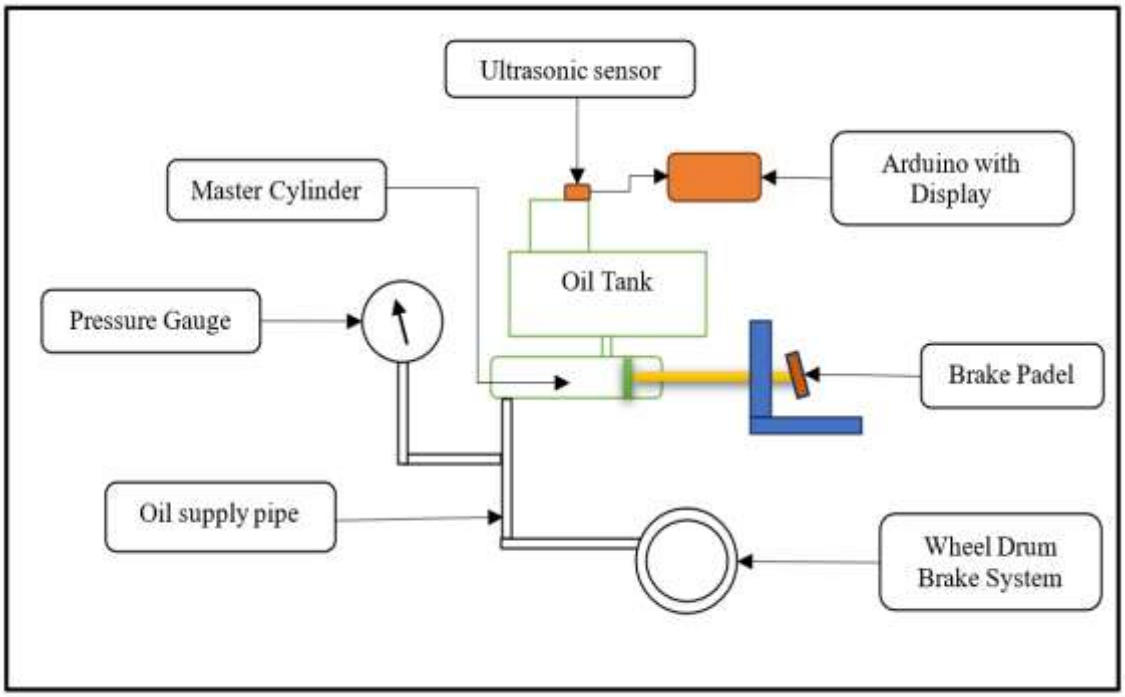
The system can be implemented in:

- Passenger vehicles
- School buses
- Heavy trucks
- Electric vehicles
- Emergency vehicles

It is especially useful in high-speed highways and hilly terrains.

CHAPTER NO.4
METHODOLOGY

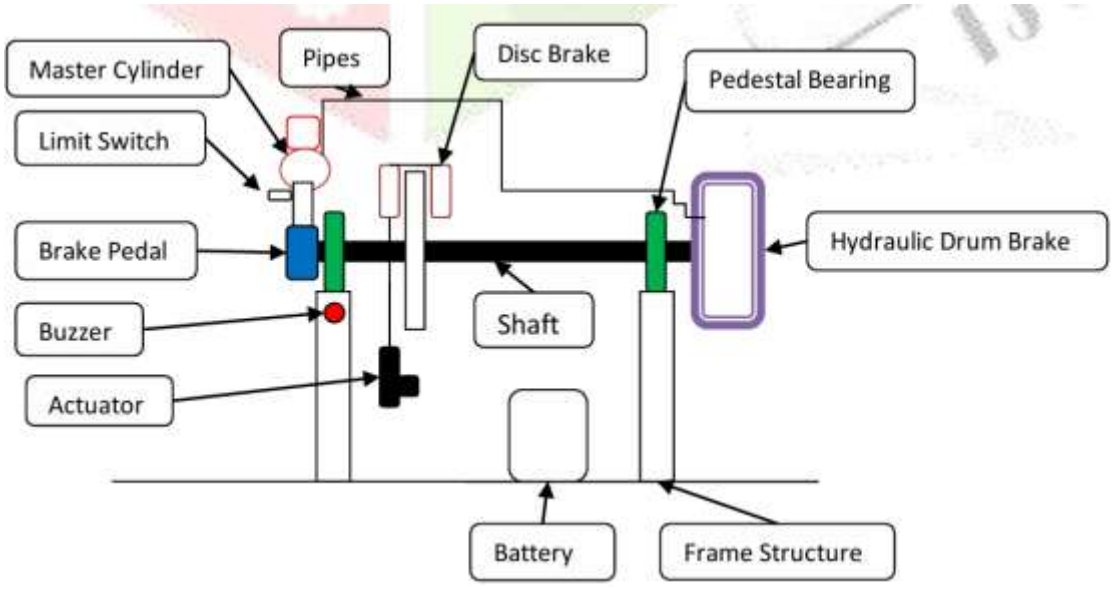
The methodology of the Brake Failure Detecting and Alerting System is based on continuous monitoring of critical braking parameters to ensure vehicle safety and early fault detection. The system integrates multiple sensors such as a brake pressure gauge, brake fluid level sensor, which are strategically installed in the braking system. These sensors continuously collect real-time data related to hydraulic pressure, brake fluid level. The sensed data is transmitted to a microcontroller (such as Arduino), where it is processed and analyzed. The microcontroller converts analog signals into digital values using an analog-to-digital converter and compares them with predefined threshold limits set according to standard braking conditions.



If any parameter deviates from the safe operating range, the system identifies it as a potential fault condition. For example, a sudden drop in hydraulic pressure may indicate brake line failure, low brake fluid level may suggest leakage may indicate reduced braking efficiency. The system uses rule-based logic and validation checks to minimize false alarms and ensure reliable detection. Once a fault is detected, the alerting mechanism is activated, which may include a visual warning through LEDs or an LCD display and an audible warning through a buzzer.

The entire system is tested under various operating conditions such as normal braking, sudden braking, simulated fluid leakage to evaluate its accuracy, response time, and reliability. Proper calibration and threshold adjustment are performed to enhance performance. Thus, the proposed methodology provides a real-time, cost-effective, and efficient solution for detecting brake failures and alerting drivers promptly to prevent accidents and improve vehicle safety.

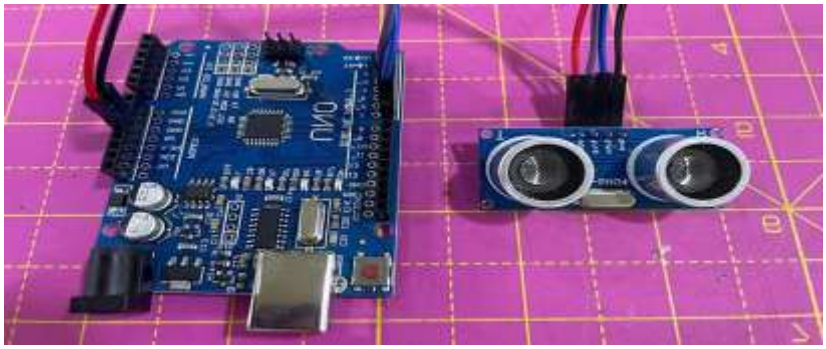
When brake fails then this system takes place



CHAPTER NO.5
DESIGN,WORKING AND PROCESSES

Components used:

1) Ultra sonic sensor with Arduino



The oil level in a master cylinder oil tank can be measured using an ultrasonic sensor based on the time-of-flight principle. The sensor, mounted at the top of the reservoir, emits high-frequency ultrasonic sound waves (typically 40 kHz) toward the oil surface. These waves travel through the air space above the oil, strike the liquid surface, and reflect back to the sensor. The microcontroller, such as an Arduino, measures the time interval between sending the pulse and receiving the echo. Since the speed of sound in air is known (approximately 343 m/s at room temperature), the distance between the sensor and the oil surface is calculated using the formula: Distance = (Speed of Sound × Time) ÷ 2, where the division by two accounts for the forward and return travel of the sound wave.

Once the distance to the oil surface is determined, the actual oil level is calculated by subtracting this measured air gap from the total height of the tank. For example, if the tank height is fixed and calibrated during installation, any increase in measured distance indicates a drop in oil level. The system can continuously monitor this value and compare it with predefined threshold levels. If the oil level falls below a safe limit, the microcontroller activates a warning system such as an LED indicator, buzzer, or dashboard notification to alert the driver.

This non-contact measurement method is particularly suitable for brake master cylinders because it avoids direct contact with brake fluid, which can be corrosive and sensitive to contamination. Additionally, the absence of mechanical moving parts reduces wear and increases reliability. However, proper calibration is necessary to account for factors such as temperature variations (which affect the speed of sound), tank geometry, possible fluid surface turbulence, and vapor presence inside the reservoir. With correct installation and calibration, ultrasonic sensing provides an accurate, safe, and durable solution for monitoring oil levels in automotive master cylinder systems.

Why Ultrasonic Method?

i) Non-contact (no corrosion from brake fluid)
ii) No mechanical wear
ii) Good accuracy for small tanks
iv) Safe (no direct electrical contact with fluid)

2) Master Cylinder

A **master cylinder** is a hydraulic device used in vehicle braking systems to convert mechanical force from the driver's foot into hydraulic pressure. When the brake pedal is pressed, a pushrod moves a piston inside the master cylinder. This piston compresses the brake fluid stored in the reservoir, creating hydraulic pressure. Because brake fluid is incompressible, the pressure is transmitted evenly through brake lines to the wheel cylinders or brake calipers, which then press the brake pads against the disc or drum to slow down or stop the vehicle.

In most modern vehicles, a **tandem (dual) master cylinder** is used for safety. It contains two separate pistons and hydraulic circuits inside one body. If one circuit fails due to leakage, the other circuit can still operate, allowing partial braking. The master cylinder typically includes a fluid reservoir mounted on top, which stores brake fluid and compensates for fluid expansion and minor losses over time.

The working principle of the master cylinder is based on **Pascal's Law**, which states that pressure applied to a confined fluid is transmitted equally in all directions. The pressure generated depends on the force applied to the brake pedal and the cross-sectional area of the piston. Many vehicles also use a brake booster (vacuum or hydraulic) to amplify the driver's input force, reducing the effort needed to apply the brakes.

Proper maintenance of the master cylinder is critical for vehicle safety. Low brake fluid levels, air in the system, internal seal wear, or leakage can reduce braking efficiency and may lead to brake failure. Regular inspection of brake fluid level and condition ensures reliable braking performance.

3) Drum Brake

A **drum brake** is a type of braking system in which brake shoes press outward against the inner surface of a rotating drum attached to the wheel to slow or stop a vehicle. It operates on the principle of friction. When the driver presses the brake pedal, hydraulic pressure from the master cylinder is transmitted to the wheel cylinder inside the drum. The wheel cylinder contains two pistons that push the brake shoes outward. These shoes, lined with friction material, make contact with the inner surface of the drum, creating friction that reduces the wheel's rotational speed.

When the brake pedal is released, return springs pull the brake shoes back to their original position, away from the drum, allowing the wheel to rotate freely. The backing plate supports all the components, and an adjuster mechanism maintains proper clearance between the shoes and the drum as the lining wears down.

Drum brakes are commonly used on the rear wheels of many vehicles because they are cost-effective and provide strong braking force. They also integrate easily with the parking brake system. However, compared to disc brakes, drum brakes dissipate heat less efficiently and may experience brake fade under heavy or repeated braking. Despite this, they remain reliable and widely used in many passenger cars, trucks, and motorcycles.

4) Pedestal Bearings

A **pedestal bearing**, also known as a **plummer block or pillow block bearing**, is a mounted bearing unit used to support a rotating shaft with the help of compatible bearings and a housing. It is designed to provide support for a shaft that runs parallel to the mounting surface. The assembly consists of a bearing fitted inside a cast iron or steel housing, which is bolted to a base or foundation. The shaft passes through the inner race of the bearing and rotates freely while being properly aligned and supported.

The working principle of a pedestal bearing is to reduce friction between the rotating shaft and the stationary support structure. When the shaft rotates, the rolling elements (balls or rollers) inside the bearing reduce friction by converting sliding motion into rolling motion. The housing protects the bearing from dust, dirt, and external damage, while lubrication (grease or oil) minimizes wear and heat generation.

Pedestal bearings are widely used in machinery such as conveyors, motors, pumps, agricultural equipment, and line shafting systems. They are preferred because they are easy to install, replace, and maintain. The split-type plummer block design allows the upper part of the housing to be removed for quick inspection or replacement of the bearing without disturbing the shaft alignment. Proper lubrication and alignment are essential to ensure long service life and smooth operation of the pedestal bearing with shaft.

5) Shaft

In a **brake failure project**, a **shaft** is mainly used to transmit mechanical motion or torque between components of the braking or safety mechanism. Its exact role depends on the project design, but generally it acts as a rotating or supporting member that connects parts such as gears, cams, wheels, or emergency braking mechanisms.

In many student brake failure models (especially mechanical safety systems), a shaft is connected to the wheel or motor. Under normal conditions, the shaft rotates freely. When brake failure is detected (for example, loss of hydraulic pressure), a mechanical locking mechanism such as a cam, ratchet, or secondary brake engages the shaft. This engagement either slows down or stops the rotation, simulating an emergency braking system. The shaft therefore becomes the key element that transfers motion from the driving motor to the wheel and also allows the emergency mechanism to act directly on the rotating system.

6) LED Display

An **LCD (Liquid Crystal Display)** is widely used in engineering projects to display parameters such as oil level, pressure, temperature, or warning messages. In a brake failure or oil level monitoring project, a **16×2 LCD display** is commonly used because it is simple, cost-effective, and easy to interface with microcontrollers like Arduino.

The working principle of an LCD is based on liquid crystals that control light transmission. The display does not emit light directly; instead, it uses a backlight and liquid crystals to block or allow light to pass through, forming characters on the screen. A 16×2 LCD can display 16 characters per line and has two lines, making it suitable for showing messages like:

- "Oil Level: 75%"
- "LOW OIL WARNING"
- "Brake Failure!"

7) Buzzer

A **buzzer** is an electronic device that produces a sound signal to alert the user. In a brake failure or oil level monitoring project, a buzzer is commonly used to **indicate low oil level** in the master cylinder reservoir. When the oil level drops below a preset threshold, the microcontroller (e.g., Arduino) activates the buzzer to warn the driver or operator immediately.

8) Motor

A **wiper motor** is an electric motor commonly used in automotive applications, designed to convert electrical energy into rotational mechanical motion. In a **brake failure or oil level project**, a wiper motor can be used to **rotate a drum shaft**, simulating the wheel or mechanical system for testing purposes.

Operation in Drum Shaft Rotation

- The wiper motor is mechanically coupled to the **drum shaft** via gears, pulleys, or direct coupling.
- When powered, the motor rotates the shaft at a controlled speed.
- This rotation allows simulation of wheel movement, enabling testing of braking systems, oil level monitoring, or emergency brake mechanisms in the project.
- The motor may also be used to automate movement for experiments, replacing manual rotation.

9) Disc & Caliper with Door locking Actuator

How It Works:

- The **door locking actuator** contains a small DC motor and a linkage mechanism inside a compact housing.
- When activated by an electrical signal, the actuator moves a **locking arm, pin, or disc**.
- This locking component is positioned so that it **engages directly with the rotating disc or its shaft**, preventing further rotation.
- Essentially, the actuator's locking arm presses against the rotor or a specially attached locking disc fixed to the rotor shaft, acting as a physical brake.

10) Battery

Here's how it is typically used in this project:

i)Powering Sensors

Sensors like **ultrasonic level sensors** or **pressure sensors** require a stable DC voltage (often 5–6V).

The 6V battery supplies continuous power, ensuring the sensors can monitor oil level or brake pressure in real time.

ii) Driving Actuators

Devices such as **door locking actuators, wiper motors, or electromechanical brake simulators** need DC voltage to operate.

The 6V battery provides the necessary current to move the locking pins or rotate shafts, enabling emergency stop mechanisms in case of simulated brake failure.

iii)Powering Displays and Alerts

LED displays, LCD screens, and buzzers require low-voltage DC.

The 6V battery ensures visual (LCD/LED) and auditory (buzzer) alerts function even if mains power is unavailable.

iv)Portable and Independent Operation

A rechargeable battery allows the brake failure project to be **portable**, enabling testing and demonstration without being tethered to mains power.

Rechargeable capability ensures repeated testing without replacing batteries, reducing project costs.

v)Safety Consideration

Using a low-voltage 6V battery is **safe for prototype projects**, preventing risk of electrical hazards while demonstrating emergency braking or safety mechanisms.

Picture of Actual model:

CHAPTER NO.6
RESULTS AND APPLICATIONS

The proposed Brake Failure Detecting and Alerting System was successfully designed and implemented to monitor critical brake parameters in real time. The system effectively detected abnormal conditions such as low brake fluid level, pressure drop, overheating, and excessive brake pad wear. During testing under normal and simulated fault conditions, the sensors accurately transmitted data to the microcontroller, which processed the inputs and compared them with predefined threshold values. Whenever a parameter exceeded the safe limit, the system immediately activated the alert mechanism through visual indicators and an audible buzzer.

1) When oil level in oil reservoir of master cylinder is below 25% then buzzer can alert the driver immediately.
2) Pressure gauge indicates the oil level when it's falls below 40 bar then driver can understand leakage occurs.
3) When brake failure occurs then emergency braking system can lower the speed of vehicles.

Applications of this Project

1. Used in passenger cars for continuous brake condition monitoring.

2. Applied in commercial vehicles such as trucks and buses to enhance road safety.

3. Implemented in public transportation systems to improve passenger protection.

4. Used in electric vehicles (EVs) for advanced safety and performance monitoring.

5. Integrated into autonomous vehicles for intelligent brake fault detection.

6. Applied in fleet management systems for real-time vehicle health tracking.

7. Used in industrial vehicles like forklifts and construction equipment for operational safety.

8. Implemented in mining and heavy-duty vehicles where brake reliability is critical.

9. Supports predictive maintenance to reduce repair and maintenance costs.

10.Contributes to accident prevention and smart vehicle technology development.

Advantages of this Project

1. Enhanced Safety

- **Early Warning**: Detects brake system issues (like low brake fluid, worn pads, or hydraulic failures) before they lead to accidents.

- **Accident Prevention**: Alerts the driver in real-time, giving them time to slow down safely or take alternative measures.

- **Reduces Fatalities**: Brake failure is a leading cause of accidents; timely alerts can significantly reduce injury risks.

2. Improved Vehicle Reliability

- **Proactive Maintenance**: Drivers can service brakes before a total failure occurs, extending the lifespan of brake components.

- **Reduced Breakdown Incidents**: Helps prevent situations where a car becomes uncontrollable due to brake failure.

3. Cost Savings

- **Prevents Major Repairs**: Early detection avoids more expensive repairs caused by severe damage from brake failure.

- **Reduces Insurance Costs**: Some insurers may offer discounts for vehicles with advanced safety systems.

4. Driver Awareness & Confidence

- **Real-Time Feedback**: Drivers are constantly informed about the health of their brake system.
- **Enhanced Driving Confidence**: Especially useful for new drivers or in challenging driving conditions (mountains, heavy traffic).

5. Integration with Advanced Car Systems

- **Supports ADAS**: Can be integrated with Advanced Driver Assistance Systems for autonomous emergency braking or collision avoidance.
- **Data Logging**: Provides valuable data for diagnostics and future vehicle design improvements.

6. Regulatory & Market Advantage

- **Compliance with Safety Standards**: Many countries are pushing for stricter vehicle safety requirements.
- **Consumer Appeal**: Vehicles with active safety features have a competitive edge in the market.

CHAPTER NO.7
CONCLUSION AND FUTURE SCOPE

Conclusion

The proposed Brake Failure Detecting and Alerting System was successfully designed and implemented to monitor critical brake parameters in real time.We conclude that our designed project can give buzzer & display warming message for low oil level in the oil reservoir & leakage of fluid in pressure lines.By implementing this system in cars & other vehicles we can avoid road accidents due to brake failure.

Future Scope

1. Integration with Artificial Intelligence (AI) for predictive brake failure analysis.
2. Integration with Anti-lock Braking System (ABS) for enhanced safety control.
3. Development of a mobile application for real-time brake status monitoring.
4. Cloud-based data storage for vehicle health tracking and analysis.
5. Implementation of IoT technology for remote monitoring and alerts.
6. Addition of GPS module to send location details during brake failure alerts.
7. Use of advanced sensors for more accurate and faster fault detection.
8. Integration with vehicle dashboard systems for detailed digital display.
9. Development of self-diagnosis and automatic calibration features.
10. Expansion of the system to monitor complete vehicle safety parameters such as engine and tire condition.

CHAPTER NO.8
COST ESTIMATION AND HARDWARE

Sr.No	Component Name	Quantity	Cost
1.	Frame / Body	1	**999**
2.	Arduino Sensors	1	**1499**
3.	Buzzer	1	**49**
4.	LCD Display	1	**199**
5.	DC Motor	2	**499**
6.	Battery	1	**1499**
7.	Drum	4	**499**
8.	Locking Actuator	1	**549**
9.	Disc brake	1	**399**
10.	Pedestal Bearing	2	**999**
11.	Master Cylinder	1	**499**
Total			**7689**

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