

Major Project Report

#### Design and Development of autopilot vehicle braking system

**Submitted by**



Under the Guidance of

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*Certificate*

This is to certify that the Major Project work entitled “**Design and Development of autopilot vehicle braking system**

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Place: VIT Pune Date: 24/11/23

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#### ABSTRACT

The Autopilot Vehicle Braking System is a groundbreaking major project aimed at enhancing the safety and efficiency of automotive transportation. This system leverages advanced sensor technologies to enable autonomous braking capabilities in vehicles. The primary objective is to mitigate the risk of collisions by providing an intelligent braking system that can autonomously respond to potential hazards.

The project involves the integration of sensors such as cameras, lidar, radar, and ultrasonic devices to continuously monitor the vehicle's surroundings. The collected data is processed in real-time and analyzes various parameters, including the proximity of obstacles, vehicle speed, and road conditions. Based on this analysis, the system can autonomously engage the braking system to prevent or minimize the impact of collisions.

Key features of the Autopilot Vehicle Braking System include adaptive braking, which adjusts the braking force based on the severity of the impending collision, and predictive braking, which anticipates potential hazards and initiates braking measures proactively. The system is designed to be compatible with a wide range of vehicles, offering a scalable solution for both conventional and electric vehicles.

Through rigorous testing and validation, the Autopilot Vehicle Braking System aims to meet stringent safety standards and regulations. The successful implementation of this project holds the potential to revolutionize the automotive industry by significantly reducing the incidence of accidents and enhancing overall road safety. As autonomous driving technologies continue to evolve, the Autopilot Vehicle Braking System represents a crucial step towards achieving a safer and more efficient transportation ecosystem.

* 1. **Introduction**

### CHAPTER - 1

Through rigorous testing and validation, the Autopilot Vehicle Braking System aims to meet stringent safety standards and regulations. The successful implementation of this project holds the potential to revolutionize the automotive industry by significantly reducing the incidence of accidents and enhancing overall road safety. As autonomous driving technologies continue to evolve, the Autopilot Vehicle Braking System represents a crucial step towards achieving a safer and more efficient transportation ecosystem.

In the dynamic landscape of modern transportation, where vehicular safety stands as a paramount concern, this project emerges as a groundbreaking initiative poised to revolutionize the automotive industry. At its core lies the development of an Autopilot Vehicle Braking System meticulously integrated with the transformative capabilities of the Internet of Things (IoT). This pioneering system is conceived as a proactive response to the persisting challenges associated with road safety, seeking to redefine the conventional paradigms of collision prevention through the amalgamation of cutting-edge technology and vehicular control mechanisms.

The crux of this initiative lies in equipping vehicles with an intelligent, real-time hazard detection system that leverages the interconnectedness afforded by IoT. By employing an array of sensors and communication technologies, the Autopilot Vehicle Braking System aims to empower vehicles with the capability to autonomously identify potential threats in their immediate surroundings. The subsequent autonomous application of brakes constitutes a paradigm shift in vehicular safety, circumventing the limitations of human reaction time and ushering in an era of proactive accident prevention.

In addressing the multifaceted challenges inherent in this endeavor, the project meticulously navigates the intricacies of obstacle detection, communication latency, seamless integration with existing vehicular systems, and the imperative adherence to safety standards and regulations. Moreover, considerations extend beyond individual vehicle applications to encompass scalability, envisioning deployment across diverse vehicular landscapes, from personal automobiles to expansive commercial fleets.

This ambitious undertaking not only holds the promise of significantly reducing the incidence of accidents attributed to human error or unforeseen obstacles but also anticipates transformative implications for the future of transportation. By seamlessly weaving together the realms of artificial intelligence, IoT, and vehicular dynamics, the Autopilot Vehicle Braking System emerges not just as a technical innovation but as a catalyst for redefining the contours of vehicular safety and charting the course toward a more secure and intelligent automotive future.

#### Historical Background

The history of braking systems is a fascinating journey that spans centuries, evolving from rudimentary mechanisms to sophisticated technologies designed to ensure vehicle and road safety. Here's a brief overview:

**Wooden Block Brakes (Late 19th Century):** The earliest known braking systems involved wooden blocks or shoes that were manually pressed against the iron-rimmed wheels of horse-drawn carriages. The friction generated between the blocks and the wheels was the primary means of slowing down or stopping the vehicle.

**Mechanical Linkage Brakes (Early 20th Century):** With the advent of automobiles, braking systems evolved to include mechanical linkages. These systems utilized rods and cables to transmit the force applied to the brake pedal to the brakes on each wheel. Drum brakes, where shoes pressed against the inside of a rotating drum, became a common early design.

**Hydraulic Brakes (1920s):** The introduction of hydraulic brakes marked a significant advancement in braking technology. Developed by companies like Lockheed, hydraulic brakes used fluid to transmit force, providing more consistent and efficient braking. This innovation allowed for a more even distribution of braking force among all wheels.



**Disc Brakes (1950s-1960s):** The widespread adoption of disc brakes began in the 1950s. Initially used in high-performance and racing vehicles, disc brakes offered improved heat dissipation and better stopping power compared to drum brakes. Over time, they became standard in many automobiles.

**Anti-lock Braking System (ABS) (1970s):** ABS, introduced in the 1970s, represented a breakthrough in braking technology. Developed to prevent wheel lockup during hard braking, ABS systems modulate brake pressure rapidly, allowing the driver to maintain steering control even under heavy braking.

**Electronic Brakeforce Distribution (EBD) and Brake Assist (1990s):** EBD and Brake Assist technologies emerged to enhance braking efficiency. EBD optimizes the distribution of braking force among wheels, while Brake Assist detects emergency braking situations and applies maximum braking force.

**Electronic Stability Control (ESC) (2000s):** ESC systems, building upon ABS and traction control, became standard in many vehicles. ESC helps prevent skidding and loss of control by selectively applying brakes to individual wheels.

**Regenerative Braking (21st Century):** In the realm of electric and hybrid vehicles, regenerative braking has gained prominence. This technology converts kinetic energy into electrical energy during braking, which is then used to recharge the vehicle's battery.

**Autonomous Emergency Braking (AEB) and Advanced Driver Assistance Systems (ADAS) (Present):** The latest advancements include AEB, a form of autonomous braking that detects imminent collisions and applies the brakes if the driver doesn't respond. These technologies are integral components of broader ADAS aimed at enhancing overall vehicle safety.The history of braking systems reflects a continuous quest for improved performance, safety, and control, with each era contributing to the sophisticated and interconnected systems found in today's automobiles.

* 1. **Impact Factor**

### CHAPTER - 2

#### Literature Review

Understanding and assessing the impact factors in an Automatic Emergency Braking (AEB) system is crucial for the effectiveness and reliability of autopilot braking systems

* + 1. Vehicle Factor
       - Complex Driving Situations

Autopilot braking systems should be able to handle complex driving scenarios, such as curved roads, intersections, overtaking, and lane changes. This capability would make the system more versatile and effective, and would contribute to overall road safety. [1]

* + - * Speed Considerations

It is important to recognize that AEB systems are generally designed for low- and medium-speed traffic scenes. Understanding the limitations of these systems in high-speed scenarios is crucial, as it will ensure the responsible use of the technology and set realistic expectations for users. This information is essential for both the design and testing of autopilot braking systems. [1]

* + - * Field-of-View (FoV) Angle

The field of view (FoV) angle of sensors has a significant impact on collision avoidance, especially in scenarios involving pedestrians and bicyclists. A thorough understanding of the optimal detection angles for various scenarios is crucial for designing effective sensors and enhancing the effectiveness of the autopilot braking system, particularly in preventing accidents involving vulnerable road users. [1]

* + - * System Factors & Collision Avoidance Effect

System factors such as errors, braking delay, maximum deceleration, and control strategy have a direct impact on the effectiveness of collision avoidance. Addressing system errors, optimizing braking delay, and fine-tuning control strategies are crucial for enhancing the reliability and performance of the autopilot braking system in real-world scenarios. [1]

By addressing system errors, optimizing braking delay, increasing maximum deceleration, and fine-tuning control strategies, we can significantly enhance the reliability and performance of the autopilot braking system in real-world

scenarios, making it a more effective tool for collision avoidance and improving overall road safety. [1]

* + 1. Environment Factor
       - Weather & Light Conditions

The performance of sensor-based systems can be significantly impacted by adverse weather conditions and low-light environments. Recognizing the limitations of sensors in rain, snow, fog, and darkness is crucial for designing AEB systems that maintain reliability and effectiveness across a variety of weather and lighting scenarios. This involves incorporating additional technologies or strategies to compensate for the challenges posed by these conditions. Ensuring the safety and effectiveness of AEB systems in diverse conditions is paramount, and careful consideration of sensor limitations is essential to achieving this goal. [1]

* + - * Road Conditions Adhesion Coefficient

The effectiveness of braking systems is highly dependent on road conditions, particularly the adhesion coefficient, which represents the tire's grip on the road surface. Adapting the AEB system to account for varying adhesion coefficients is essential for accurately predicting braking distances.By incorporating this adaptability, the system's ability to prevent collisions remains consistent across different road surfaces and conditions, contributing to enhance overall safety. [1]

#### Work done by Others in this area

To gain insights into existing approaches to the Autopilot Braking System, we conducted a comprehensive review of literature published in reputed international journals.

The paper published by Yipeng Yang [1], covers various aspects related to AEB systems, including their subsystems, testing and evaluation methods. The paper highlights the importance of AEB in enhancing vehicle safety. The author also discusses the three primary subsystems of AEB – Environment Perception, Decision-Making and Execution. The paper further addresses the importance of sensor technology like radar, lidar, cameras, and thermal sensors in the environmental perception subsystem. The author discussed the 2 main methods of testing – virtual tests using simulation software and closed field tests with real vehicles.

The paper published by Chunjiang Yang [2], the author has conducted research and presented a study on improving the performance of the Advanced Emergency Braking system on curved roads. The authors designed a target recognition model specifically tailored for AEB systems operating on curved roads. The AEB control strategy integrates

two models, the Time-to-Collision (TTC) model and the safety distance model. The proposed models and strategies were validated through simulations using Carsim and MATLAB software. Results from simulations demonstrated the effectiveness of the designed target recognition model and fusion control strategy in preventing collisions while maintaining comfort and safety. The proposed models and strategies are aligned with Euro-NCAP standards, reinforcing their applicability to real-world driving scenarios.

The paper published by R. Vaibhav [3], has developed and tested a real-time autonomous braking system using electronic components, adhering to UN Regulations standards for various car models. The prototype successfully operated under different conditions, employing the kinematic method to determine braking distances on dry and wet roads. The braking distance on dry roads ranged from 3.328m at 10km/hr to 73.14m at 50 km/hr in surprise scenarios. On wet roads, the braking distance varied from 1.107 m to 28.92 m at 10 km/hr and 40 km/hr, respectively. Additionally, the work-energy method was discussed, which showed that at 30 km/hr, the braking distance ranged from 5.378 m (expected) to 65.51m (surprise). The study emphasizes the importance of automated braking in reducing traffic fatalities and enabling autonomous driving. The integration of a lidar sensor expand the vehicle’s sensing range, contributing to improved awareness of the surrounding and effective accident prevention. The research also highlights the role of linear actuators in scenarios where drivers are unable to intervene, showcasing their significance in an autonomous emergency braking system. The results indicate that braking distances vary under different conditions, with shorter distances observed in dry conditions compared to wet conditions. The findings contribute valuable insights into the performance and optimizations of autonomous braking systems for enhanced road safety.

## CHAPTER 3

#### Types of braking systems

There are several types of braking systems used in automobiles, each with its own advantages and disadvantages. The most common types of braking systems include:

#### Hydraulic Brakes: Disc Brakes:

These are the most common type of brakes used in modern vehicles. They consist of a brake disc, brake caliper, and brake pads. When the brake pedal is pressed, hydraulic fluid is sent to the caliper, which then presses the brake pads against the disc, creating friction and slowing down the vehicle.

**Components:** Consists of a brake disc (rotor), brake caliper, and brake pads.

**Operation:** When the brake pedal is pressed, hydraulic fluid is sent to the caliper.

**Caliper Action:** The caliper contains pistons that press the brake pads against the rotating disc.

**Friction:** This contact between the brake pads and the disc creates friction, slowing down the vehicle.

**Commonality**: Widely used in front-wheel and some rear-wheel braking systems due to their efficiency and heat dissipation.

#### Advantages of Disc Brakes:

1. **Better Heat Dissipation:** Disc brakes dissipate heat more efficiently than drum brakes, making them less prone to fade under heavy or prolonged braking.
2. **Shorter Stopping Distances:** Disc brakes generally provide better stopping power, contributing to shorter stopping distances. This is especially crucial in emergency braking situations.
3. **Effective in Wet Conditions:** Disc brakes are less prone to water buildup and are generally more effective in wet conditions compared to drum brakes, which can experience reduced performance when wet.
4. **Ease of Inspection and Maintenance:** Disc brakes are typically easier to inspect and maintain. The components are more accessible, and it's easier to check the condition of the brake pads and discs.
5. **Less Weight:** Disc brake systems are often lighter than drum brake systems, contributing to overall vehicle weight reduction.
6. **Aesthetic Appeal:** The visible components of disc brakes, such as the rotors and

calipers, can be designed for aesthetic appeal. This is especially relevant for high-performance or sports vehicles.

#### Disadvantages of Disc Brakes:

1. **Cost:** Disc brake systems are often more expensive to manufacture and replace compared to drum brakes. This can contribute to higher initial vehicle costs.
2. **Complexity:** Disc brake systems are more complex in design compared to drum brakes. This complexity can lead to increased maintenance and repair costs.
3. **Vulnerability to Corrosion:** In regions with high corrosion potential, the exposed nature of disc brakes can make them more vulnerable to corrosion compared to the enclosed nature of drum brakes.
4. **Noise:** Disc brakes can be noisier than drum brakes, especially in certain conditions. This noise is often attributed to factors such as brake pad material and rotor design.
5. **Parking Brake Integration:** Some disc brake systems use a separate parking brake mechanism, which can be less convenient than the integrated design found in some drum brake setups.

#### Drum Brakes:

Drum brakes consist of a brake drum, brake shoes, and wheel cylinder. When the brake pedal is pressed, hydraulic fluid forces the brake shoes against the drum, generating friction and slowing the vehicle.

**Components:** Comprises a brake drum, brake shoes, and a wheel cylinder.

**Operation:** When the brake pedal is pressed, hydraulic fluid is directed to the wheel cylinder.

**Shoe Action:** The wheel cylinder pushes the brake shoes outward against the interior surface of the brake drum.

**Friction:** Contact between the brake shoes and drum generates friction, leading to deceleration.

**Application:** Often used in the rear-wheel braking systems of many vehicles.

#### Advantages of Drum Brakes:

1. **Cost-Effective:** Drum brake systems are generally less expensive to manufacture and maintain compared to disc brakes. This can contribute to lower overall vehicle costs.
2. **Simple Design:** Drum brakes have a simpler design with fewer components, making them easier to manufacture and potentially more durable.
3. **Effective Parking Brake**: Drum brakes often have an integrated parking brake mechanism, simplifying the overall braking system design and providing a reliable parking brake.
4. **Enclosed Design:** The enclosed nature of drum brakes helps protect the internal components from environmental elements, reducing vulnerability to corrosion.
5. **Quieter Operation:** Drum brakes are often quieter than disc brakes, producing less noise during normal braking conditions.

#### Disadvantages of Drum Brakes:

1. **Heat Dissipation:** Drum brakes are less effective at dissipating heat compared to disc brakes. This can lead to a phenomenon known as brake fade, where prolonged or intense braking reduces braking efficiency.
2. **Limited Cooling:** The enclosed design that protects drum brakes from environmental elements also limits cooling, potentially leading to reduced performance under heavy or repeated braking.
3. **Longer Stopping Distances:** Drum brakes generally provide less stopping power than disc brakes, resulting in longer stopping distances. This can be a critical factor in emergency braking situations.
4. **Maintenance Challenges**: Drum brakes can be more challenging to inspect and maintain compared to disc brakes. Checking the condition of brake shoes and other components may require more effort.
5. **Weight:** Drum brake systems are often heavier than disc brake systems, contributing to increased overall vehicle weight.
6. **Uneven Brake Force Distribution:** In some cases, drum brakes may distribute braking force unevenly, leading to differences in braking performance between the left and right wheels.

#### Anti-lock Braking System (ABS):

ABS is a crucial safety feature designed to prevent wheel lock-up and skidding during hard braking, enhancing vehicle control. Here's a brief explanation:

**Objective:** ABS aims to maintain steering control by preventing wheel lock-up, especially in emergency braking situations.

#### Operation:

* 1. Wheel Sensors: ABS relies on sensors at each wheel to monitor their rotational speed.
  2. Brake Pressure Modulation: When the system detects that a wheel is about to lock up, it modulates brake pressure.
  3. Individual Wheel Control: ABS can independently adjust the braking force for each wheel, allowing it to vary the pressure rapidly and prevent skidding

#### Benefits:

1. Steerig Control: By preventing wheel lock-up, ABS ensures that the driver can maintain control over the steering, reducing the likelihood of skidding.
2. Shorter Stopping Distances: ABS can optimize braking performance, potentially leading to shorter stopping distances in certain conditions.

#### Common Use Cases:

1. Emergency Braking: ABS is particularly beneficial during emergency or hard braking situations when there's a risk of losing control.
2. Slippery Surfaces: It is effective on slippery surfaces like wet or icy roads.
3. Indicator: Many vehicles equipped with ABS have a dashboard indicator that lights up briefly during system self-check upon ignition.

#### Advantages of Anti-lock Braking System (ABS):

1. **Improved Steering Control:** ABS prevents wheel lock-up during hard braking, allowing the driver to maintain steering control. This is crucial for avoiding obstacles and navigating emergency situations.
2. **Shorter Stopping Distances:** By preventing wheel lock-up, ABS helps maintain effective braking and can contribute to shorter stopping distances, especially on slippery surfaces.
3. **Enhanced Stability:** ABS enhances overall vehicle stability during braking, reducing the likelihood of skidding and maintaining directional stability.
4. **Effective on Varied Surfaces:** ABS performs well on a variety of road surfaces, including wet or icy conditions, where traditional brakes might be less effective.
5. **Prevention of Flat Spots:** ABS prevents the formation of flat spots on tires that can occur when wheels lock up, improving tire longevity.
6. **Adaptability:** ABS can adapt to changing driving conditions, adjusting brake pressure independently for each wheel, enhancing performance in diverse situations.

#### Disadvantages of Anti-lock Braking System (ABS):

1. **Increased Stopping Distances on Some Surfaces:** While ABS generally improves stopping distances, on certain surfaces like loose gravel or snow, it may

increase stopping distances compared to skilled, non-ABS braking techniques.

1. **Cost:** Vehicles equipped with ABS tend to be more expensive due to the additional cost of the system.
2. **Complexity:** ABS systems are complex, incorporating sensors, control units, and hydraulic components. This complexity can lead to increased maintenance and repair costs.
3. **Dependency on Proper Maintenance:** Proper maintenance is crucial for the effective operation of ABS. Any malfunction in the system may compromise its performance.
4. **Driver Over-Reliance:** Some drivers may develop over-reliance on ABS, assuming the system will always prevent accidents. While effective, ABS doesn't eliminate the need for safe driving practices.
5. **Pulsating Brake Pedal Sensation:** During ABS activation, drivers may feel a pulsating sensation in the brake pedal. This is a normal characteristic of ABS in action but may be perceived as unusual by some drivers.

#### Electronic Brake-force Distribution (EBD):

EBD optimally distributes braking force between the front and rear wheels based on the load each wheel is carrying. This improves braking performance and stability. EBD is a technology that enhances braking performance by intelligently distributing the braking force between the front and rear wheels of a vehicle.

**Objective:** EBD aims to optimize the distribution of braking force to maximize efficiency and stability during braking.

#### Operation:

1. Sensor Inputs: EBD takes into account various sensor inputs such as vehicle load, weight distribution, and braking conditions.
2. Dynamic Adjustment: Based on these inputs, the system dynamically adjusts the amount of braking force sent to each wheel.
3. Individual Control: Like ABS, EBD can control the brake force for each wheel independently.

#### Benefits:

1. Improved Stability: EBD helps maintain stability during braking by ensuring that each wheel receives an appropriate amount of braking force based on its load.
2. Shorter Stopping Distances: By optimizing brake force distribution, EBD can contribute to shorter stopping distances, especially in situations where the load on the front and rear axles varies.

#### Common Use Cases:

1. Varied Load Conditions: EBD is particularly useful when the vehicle load is uneven, such as when passengers or cargo are unevenly distributed.
2. Emergency Braking: It complements ABS during emergency braking, contributing to better stability and control.

**Integration:** EBD is often integrated into the overall braking system of modern vehicles, working in conjunction with ABS and other braking technologies.

#### Advantages of Electronic Brake-force Distribution (EBD):

1. Improved Braking Performance: EBD optimally distributes braking force between the front and rear wheels, contributing to more balanced and effective braking performance.
2. Enhanced Stability: By adjusting brake force based on load conditions, EBD helps maintain stability during braking, reducing the risk of skidding.
3. Shorte Stopping Distances: EBD can contribute to shorter stopping distances by ensuring that each wheel receives an appropriate amount of braking force based on its load.
4. Adaptability to Varied Conditions: EBD is designed to adapt to changing driving conditions, making it effective in various scenarios, including emergency braking and situations with uneven load distribution.
5. Reduced Tire Wear: EBD helps distribute braking forces more evenly, reducing uneven wear on tires and promoting longer tire life.

#### Disadvantages of Electronic Brake-force Distribution (EBD):

1. Complexity and Cost: EBD systems add complexity to the overall braking system, which may lead to increased manufacturing and maintenance costs.
2. Dependency on Sensors: EBD relies on sensors to gather information about load conditions and adjust brake force accordingly. Any malfunction in these sensors can affect the system's performance.
3. Maintenance Challenges: Like any electronic system, EBD may require specialized maintenance and repair, which can be more complex and costly than traditional braking systems.
4. Compatibility Issues: EBD systems may not be easily compatible with certain brake configurations or aftermarket brake components, limiting customization options for vehicle owners.
5. Driver Awareness: Some drivers may not be aware of the presence and function of EBD in their vehicles, potentially leading to a lack of appreciation for the safety benefits it provides.

#### Regenerative Braking:

Common in electric and hybrid vehicles, regenerative braking converts kinetic energy

into electric energy during braking. This energy is then used to recharge the vehicle's battery.

#### Parking Brake (Handbrake):

Typically a separate system from the main braking system, the parking brake is a mechanical system that engages the vehicle's brakes to keep it stationary when parked.

#### Emergency Brake (Emergency/Parking Brake):

This is a secondary braking system designed for emergency situations. It is often cable-operated and can act on either the rear wheels or all four wheels.

#### Vacuum Booster (Power Brakes):

This system uses engine vacuum to assist the driver in applying the brakes, making it easier to depress the brake pedal.

#### Hill Start Assist:

This feature prevents the vehicle from rolling backward when starting on an incline. It holds the brake for a short period after the driver releases the brake pedal, allowing time to switch to the accelerator.

The choice of braking system depends on factors such as vehicle type, size, weight, and intended use. Modern vehicles often incorporate a combination of these systems to optimize safety and performance.

## CHAPTER 4

#### Components Used -

* 1. **Arduino UNO -**

The Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.



Fig. 1.1 Arduino UNO The pin functions of the Arduino Uno:

**Digital Pins 0-13**: These pins can be used as input or output pins. When they are configured as input pins, they can read the state of a sensor or switch. When they are configured as output pins, they can control the state of an LED or other actuator.

**Analog Pins A0-A5**: These pins can be used to read analog signals from sensors. For example, they can be used to read the voltage from a potentiometer or the temperature from a thermistor.

**TX (Transmit)**: This pin is used to transmit data from the Arduino to a computer or other device.

**RX (Receive)**: This pin is used to receive data from a computer or other device.

**RESET**: This pin is used to reset the Arduino microcontroller.

**VIN**: This pin is the input voltage for the Arduino board. It can be powered by a USB connection, an AC-to-DC adapter, or a battery.

**3V3**: This pin provides a 3.3V power supply for external components.

**GND**: This pin is the ground connection for the Arduino board

#### Ultrasonic Sensor -

Ultrasonic sensors are devices that use sound waves to measure the distance to an object. They work by sending out a sound wave and then measuring the time it takes for the wave to bounce off of an object and return to the sensor. This time is then used to calculate the distance to the object.



Fig. 1.2 Ultrasonic Sensor The four pins on an ultrasonic sensor are:

**Vcc**: This pin is connected to the power supply for the sensor.

**Trig**: This pin is used to trigger the sensor to send out a sound wave.

**Echo**: This pin is used to listen for the echo of the sound wave that is reflected back from the object.

**GND**: This pin is connected to the ground for the sensor.

#### DC Motor -

A DC motor is an electrical motor that converts direct current electrical energy into mechanical energy. The most common type of DC motor is the brushed DC motor. Brushed DC motors have a rotating armature and a stationary field magnet. The armature is connected to a commutator, which is a set of brushes that contact

the field magnet. The brushes switch the polarity of the current to the armature, causing it to rotate.



Fig. 1.3 DC Motor The four pins on a brushed DC motor are:

**Vcc**: This pin is connected to the power supply for the motor.

**Ground**: This pin is connected to the ground for the motor.

**Control1**: This pin is used to control the direction of rotation of the motor. When this pin is connected to Vcc, the motor will rotate in one direction. When this pin is connected to ground, the motor will rotate in the opposite direction.

**Control2**: This pin is used to control the speed of the motor. The higher the voltage on this pin, the faster the motor will rotate.

**PWM**: This pin is used to control the speed of the motor using pulse-width modulation (PWM). PWM is a technique for controlling the power to an electrical device by turning it on and off rapidly. The average power to the device is proportional to the duty cycle of the PWM signal. The duty cycle is the fraction of the time that the signal is on.

#### Servo Motor -

A servo motor is a type of DC motor that uses a feedback loop to control its position. Servo motors are commonly used in robotics and automation applications. They are also used in some hobby electronics projects.



Fig. 1.4 Servo Motor The three pins on a servo motor are:

**Vcc**: This pin is connected to the power supply for the motor.

**Ground**: This pin is connected to the ground for the motor.

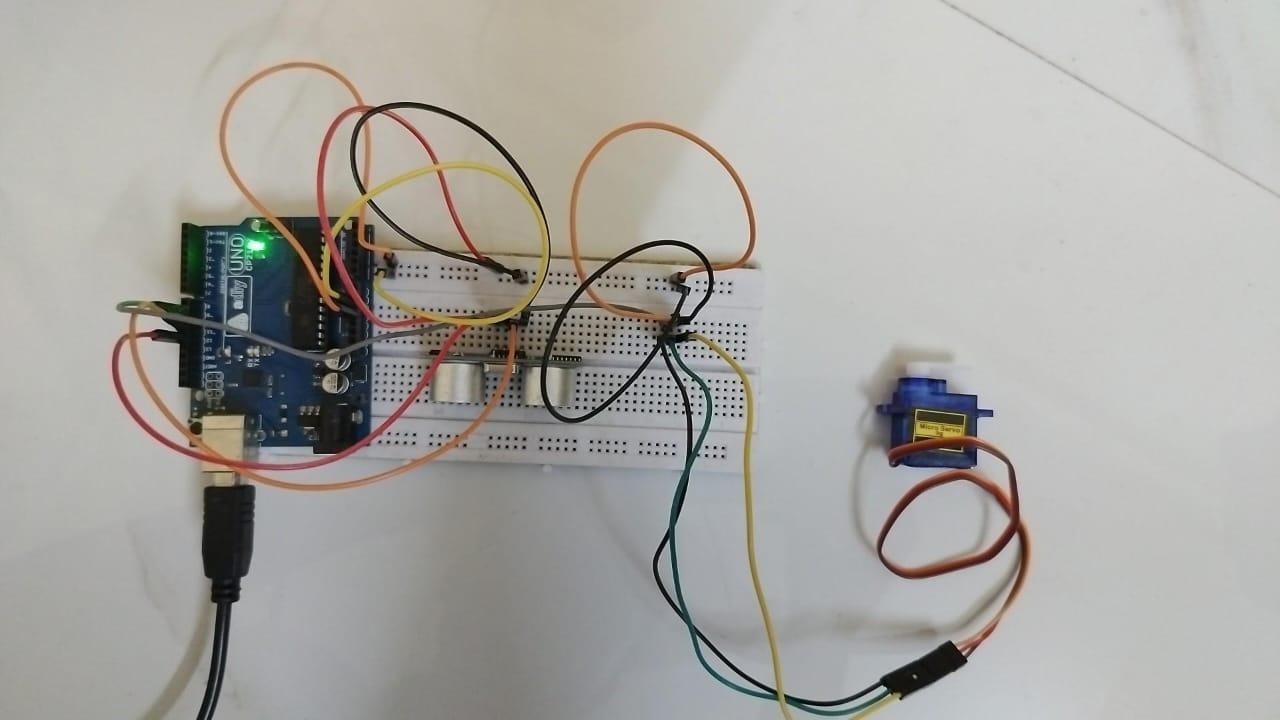
**Signal**: This pin is used to control the position of the motor. The position of the motor is determined by the width of the pulse signal that is sent to this pin. The width of the pulse signal is typically between 1 and 2 milliseconds. A pulse width of 1 millisecond corresponds to a position of 0 degrees, and a pulse width of 2 milliseconds corresponds to a position of 180 degrees.

### Working :

#### ultrasonic sensor system with servo motor by using arduino :

An ultrasonic sensor system with a servo motor, orchestrated by an Arduino microcontroller, creates an interactive setup for distance measurement and object interaction. Comprising essential components such as the Arduino board, an ultrasonic sensor (like HC-SR04), and a servo motor, this system offers a versatile platform for various applications. The wiring involves connecting the ultrasonic sensor to the Arduino for power and communication, utilizing pins like TRIG and ECHO. Simultaneously, the servo motor is linked to the Arduino for power and control, typically through a dedicated signal pin. This interconnection establishes the foundation for the seamless collaboration of these components. The operational flow is initiated as the Arduino triggers the ultrasonic sensor, prompting it to emit ultrasonic waves. These waves encounter an object, reflect back to the sensor, and the Arduino calculates the distance based on the round-trip time. Depending on this distance data, the Arduino issues commands to the servo motor, directing it to move to specific angles or positions. The Arduino code, leveraging the Servo library, plays a pivotal role in orchestrating this

dance between the ultrasonic sensor and servo motor. It not only reads distance information from the sensor but also dynamically adjusts the servo motor's position based on predefined criteria. For instance, it might position the servo differently if an object is detected in close proximity versus when it's at a considerable distance.

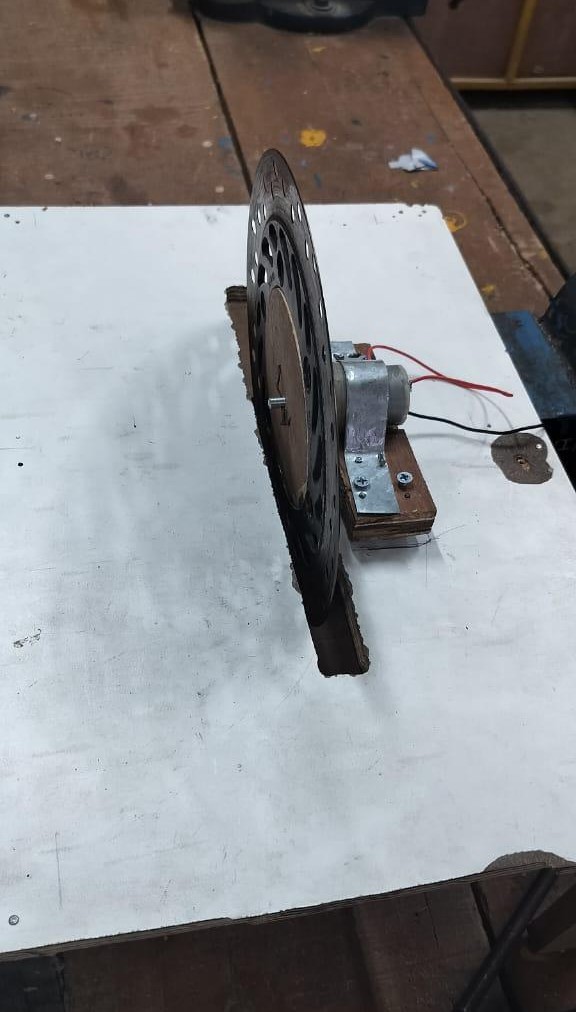


This system's versatility finds applications in robotics, automation, and interactive installations. It could be employed in projects where tracking or responding to objects within a defined range is essential, offering an engaging and responsive interaction between the physical world and the electronic system.

code of arduino:

#### servo with brake disc :

Brake discs, integral components of modern automotive braking systems, play a pivotal role in converting kinetic energy into heat to facilitate controlled deceleration. When the brake pedal is engaged, hydraulic pressure activates the brake caliper, prompting the brake pads to clamp onto the rotating brake disc. This action generates friction, transforming the vehicle's motion into thermal energy. Brake discs, typically composed of cast iron or composite materials, are designed with features like slots or drilled holes to enhance ventilation and prevent overheating during prolonged braking. The fundamental principle underlying brake discs involves the slowing down of the rotating wheel as a result of the frictional force applied by the brake pads.



The materials chosen for brake discs and their ventilation design are critical factors in ensuring optimal heat dissipation, preventing brake fade, and maintaining consistent braking performance. Ultimately, the effectiveness of brake discs contributes significantly to the safety and reliability of a vehicle's braking system.





## Arduino Code

#include <Servo.h> #define trigPin 12

#define echoPin 11 Servo servo;

int sound = 250; void setup() { Serial.begin (9600);

pinMode(trigPin, OUTPUT); pinMode(echoPin, INPUT); servo.attach(9);

}

void loop() {

long duration, distance; digitalWrite(trigPin, LOW); delayMicroseconds(2); digitalWrite(trigPin, HIGH); delayMicroseconds(10); digitalWrite(trigPin, LOW); duration = pulseIn(echoPin, HIGH);

distance = (duration/2) / 29.1; if (distance < 10) {

Serial.println("The distance is less than 10"); servo.write(180);

delay(1500);

}

else { servo.write(0);

}

if (distance > 60 || distance <= 0){ Serial.println("The distance is more than 60");

}

else { Serial.print(distance); Serial.println(" cm");

}

delay(500);

}

## ADVANTAGES

#### Enhanced Safety:

The system significantly improves overall vehicle safety by providing autonomous braking capabilities. It can detect potential collisions and initiate braking measures faster than human reaction time, reducing the risk of accidents.

#### Collision Prevention:

By integrating advanced sensor technologies, the system can proactively identify and respond to potential hazards, preventing collisions before they occur. This predictive capability enhances road safety and minimizes the likelihood of accidents.

#### Adaptive Braking:

The system incorporates adaptive braking, adjusting the braking force based on the severity of the detected obstacle. This feature ensures a proportional response, avoiding unnecessary harsh braking in non-critical situations while maintaining effectiveness in high-risk scenarios.

#### Improved Reaction Time:

The autonomous nature of the system enables it to react to potential dangers with faster response times than human drivers. This is particularly crucial in situations where split-second decisions can make a significant difference in preventing accidents.

#### Reduced Human Error:

Human error is a leading cause of accidents. The Autopilot Vehicle Braking System minimizes the impact of human-related factors such as distraction, fatigue, or delayed reaction time, contributing to a safer driving experience.

#### Proactive Collision Mitigation:

The system's predictive braking capabilities allow it to anticipate and mitigate potential collisions, even in scenarios where the driver may not have identified the risk. This proactive approach adds an additional layer of safety to the driving experience.

#### Compatibility with Various Vehicles:



The system is designed to be compatible with a wide range of vehicles, including both conventional and electric vehicles. This versatility ensures that the benefits of autonomous braking can be extended across different vehicle types and models.

#### Scalability and Integration:

As a major project, the Autopilot Vehicle Braking System is designed with scalability in mind. It can be integrated into existing automotive platforms and adapted for use in future vehicle models, contributing to the evolution of autonomous driving technologies.

# CHAPTER 6

**FUTURE SCOPE**

As automobile technology advances, the future scope of Autopilot Vehicle Braking Systems holds great promise. Here are some possible developments and points to consider:

#### Sensor Technologies of the Future:

Future systems may include more powerful sensor technology, such as upgraded radar, lidar, and video systems, allowing cars to better sense their environment and make more precise real-time choices.

#### Integration of Artificial Intelligence (AI):

Autopilot braking systems can use AI algorithms to make more complex decisions. AI can help the system assess complex events, forecast potential hazards, and adjust braking techniques accordingly.

#### Communication via V2X:

Vehicle-to-Everything (V2X) connectivity will almost certainly be critical in future autopilot braking systems. Vehicles will be able to connect with one another as well as with infrastructure, exchanging real-time information about road conditions, traffic, and potential risks.

#### Machine Learning Algorithms for Adaptive Behaviour:

Machine learning algorithms can allow autopilot braking systems to continuously learn and adapt to changing driving situations. Based on individual driving patterns and environmental conditions, this can result in more specific and effective braking responses.

#### Autopilot Braking System Integration:

Autopilot braking systems are likely to be seamlessly linked with broader autonomous driving technologies. As vehicles become more autonomous, braking systems will become increasingly important in ensuring safe and economical operation.

#### Predictive Modeling:

Based on past data, advanced analytics and predictive modeling can be utilized to anticipate probable braking circumstances, allowing vehicles to proactively alter braking



characteristics for improved safety and efficiency.

#### Enhanced Emergency Braking:

Autopilot systems may develop more advanced emergency braking capabilities, such as predictive emergency braking, which can respond to anticipated crashes before they occur.

#### Measures for Cybersecurity:

To secure autopilot braking systems from potential threats and unauthorized access, like with any new automobile technology, effective cybersecurity protections will be critical.

#### Considerations for Regulatory and Ethical Compliance:

Autopilot braking technologies will necessitate serious study of legislative frameworks and ethical standards. To enable the safe and responsible implementation of new technologies, clear norms and standards will need to be established.

#### User Acceptance and Education:

To ensure that drivers understand the capabilities and limitations of autopilot braking systems, future systems will need to include good user interfaces and educational materials. Building user acceptability and trust will be critical for widespread adoption.



# Conclusion

The Autopilot Vehicle Braking System using IoT marks a significant milestone in the realm of automotive safety and innovation. By seamlessly integrating IoT technologies, this project successfully addresses the imperative need for real-time hazard detection and autonomous response mechanisms, thereby enhancing road safety.

Through meticulous development, obstacle detection, and effective communication protocols, our system exemplifies a robust solution that strives to reduce the risks associated with human error and unforeseen obstacles. The emphasis on seamless integration with existing vehicle systems and compliance with safety standards positions this project at the forefront of advancements in intelligent transportation.

As we reflect on the journey from concept to implementation, the Autopilot Vehicle Braking System not only serves as a testament to the potential of IoT in automotive engineering but also lays the groundwork for future innovations in autonomous driving. The commitment to scalability and safety underscores the project's significance in shaping the future of vehicular technologies, promising a safer and more efficient driving experience for all.

Peering into the future, the Autopilot Vehicle Braking System not only promises a paradigm shift in contemporary automotive safety but also heralds a new era of intelligent transportation. Its scalability opens doors to widespread adoption, hinting at a future where vehicular safety is no longer a feature but an inherent aspect of the driving experience across diverse vehicle types.



# CHAPTER

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