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LC2BS – Low Cost Secondary Braking System Implemented using Arduino and Motor Speed Control Mechanism

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Abstract: In the industrialised world, roads constitute a huge problem. According to recent research, excessive or unsuitable speed as well as changes in the highway are linked to one-third of fatal or severe accidents. Accidents brought on by brake failure are a problem as well. The major cause of brake failure, pressure loss, is failure in the brake lining. A backup braking system has been created in case of unexpected brake failure or partial brake failure in order to prevent accidents. The project involves creating a hardware braking system using an Arduino, motors, and speed control that is displayed on an LCD screen. This system continuously monitors the condition of the brake wire, notifies the driver in the event of a primary brake failure, and automatically engages the secondary braking system.
Keywords: Road Safety, Secondary Braking, Communication, Brake Failure prevention, microcontroller.

I. INTRODUCTION

A group of scientists and engineers from Hughes Research Laboratories in Malibu, California, made the first ever demonstration of forward collision avoidance in 1995. Delco Electronics provided funding for the endeavour, which Ross D. Olney of HRL oversaw. For this automobile application at 77 GHz, a compact, specially made radar-head was created. On a Volvo S40 at first, then a Cadillac STS afterwards, the forward radar head together with the signal processing unit, visual, audible, and tactile feedbacks were all incorporated. Accidents now occur for a variety of reasons, with brake failure being one of the primary causes, which is brought on by inadequate maintenance and product flaw. The braking system has to be constantly monitored in cars in order to be safe. Regarding the protection of human life and health, vehicle safety encompasses the prevention of car accidents or the reduction of their negative consequences. A brake is a mechanical device that slows down a moving system, decelerating the motion of a body by causing friction between two surfaces and converting the kinetic energy of the moving body into heat.

There are three elements that determine stopping distance:

- Driver's reaction time
- Brake lag
- Braking distance

After instance, in a car, depressing only one pedal will engage the brakes on all four wheels. Hydraulic fluid, which is often bled to acquire the greatest performance of the brakes, slows down motion. The system must have air in it; else, the component won't function properly. Yet, since they need more impact braking, large trucks employ air brake systems. Braking is accomplished via a piston cylinder system. The cars have a compressor for this purpose, which is how compressed air is created to strike the brakes. Pneumatics is often used in big trucks to save braking time.

Human life expectancy is less now than it was in earlier times. Since the number of vehicles on the road is growing every day, the death rate from accidents has dramatically grown. Accidents caused by brake failure continue to be a significant problem despite the use of effective contemporary technology and advancements in the area of automation.

Despite the inclusion of additional safety measures, many fatal incidents may be prevented or reduced if there is an alternative to the failure of traditional braking systems. Hence, a system is created to automatically engage a secondary brake in the event that the current main braking system malfunctions or fails.

Our project's major goal is;

- To create a backup braking system that can function in the event of a brake failure.
- Reduce car accidents caused by brake failure by detecting and alerting the main braking system failure,
- Automatically activating the backup braking system, and more.

Automobile safety is the practise of avoiding car crashes or minimising their negative consequences, especially when they endanger the lives or health of people. There is unique safety measures included in vehicles. It is a true belief that it is outfitted and made for automotive vehicles. The reasons of brake failure must be researched in order to prevent accidents from happening as a result, and backup braking methods must be available. The effectiveness of the braking system has increased due to the addition of many additional braking systems like the Electronic Braking System (EBS) and Antilock Braking System (ABS). Yet, brake failure still occurs despite various braking systems. Lack of fluid in the master cylinder, fluid leakage in the brake linings or hose, brake overheating or fading, air in the braking system, brake pad degradation, and vehicle overloading are all causes of brake failure. When the brake line is severed, brake failure may sometimes happen. The research aims to evaluate brake failure and create a backup braking system.

II. RECENT WORKS

In this study, the authors have created a backup braking system that automatically engages in case the main braking system fails. The secondary braking system is activated when the first system fails by studying the greatest force that the driver may apply when in a panicked state. The article's primary emphasis is on the design of two-disc brakes, a supporting shaft, a spring, and a pedal lever for the secondary brake. The analysis of brake component stress and deformation is also carried out [1].

This study involves the construction of a system that places an emitter and a receiver as part of an ultrasonic setup in front of the vehicle. Waves are reflected if a barrier is present, and the receiver then picks up the signal that is transferred to Arduino. The buzzer and brakes are activated in accordance with the object's distance. The solenoid valve, which is controlled by an electrical signal and then by a pneumatic signal, is used to activate the brakes [2].

Here, the authors have developed a method in which they have created a backup braking system in the event that the primary system fails. When the pedal is depressed, the main brake is triggered, but if the wheel does not stop even after the primary brake is fully applied, an emergency scenario emerges, and the driver panics and depresses the pedal more, activating the secondary brake system. So, the secondary brake's activation is created in a manner that it activates when the pedal is pushed firmly [3].

Two sensors make up the system used in the work. The brake shoe and one sensor are linked. The brake lining is the additional sensor. The two sensors' signals are sent to a microcontroller. The sensor detects worn brake shoes and delivers a signal to the microcontroller in the event that the brake lining is severed. It evaluates the signal and activates the relevant indication. If nothing is wrong, the car will drive; otherwise, it will halt and the screen will display a brake failure warning. This brake status signal aids the user in determining the brake's state, reducing the possibility of a problem [4].

This is a structural design that includes an installation of a turbine along the direction of exhaust, followed by a connection to store the energy produced by the turbine's spin. The air was compressed using the turbine's produced electricity, which the DC compressor utilised to provide pneumatic energy to the air brake system. The air braking system, in addition to the traditional brake system, was successfully carried out using the exhaust gas [5].

This work creates a system that deals with a circuit model that examines the condition of brake wire in any automobile and alerts the driver via an audio or visual signal. The system then activates the braking system, which serves as an emergency braking where the motor rotates the wheels at a 90° angle and hydraulic system lowers the emergency wheels to reach the ground in order to make in synchronisation with the vehicle velocity and the driver can activate the emergency brakes [6].

In order to continually monitor the braking system while the car is moving, writers created a system. The mechanism is automatically engaged in the event of a brake failure, alerting the driver through a buzzer and shutting off electricity as well. To protect drivers and passengers, the system gradually applies the emergency brakes [7].

Every time the main brake system fails to function, an auxillary braking system is intended to automatically engage. It is done by assigning a threshold value to the amount of pressure the driver applies to the brake pedal; for example, if the main brake fails, a situation of emergency emerges as a result of which he applies brakes with considerably more force under panic state.

The secondary brakes are immediately engaged as a result of this force, which is larger than the one normally applied. A turbine positioned in the exhaust pipe's route, together with a connection to store the energy produced by the turbine's spin, make up an air braking system that may be added to the traditional braking system. Compressing the air in the DC compressor, which supplies pneumatic power to the air brake system, uses the electric power provided by the turbine. As compared to ABS and EBS systems, the system designed is determined to be extremely cost-effective and primarily focuses on the safety of the driver and the vehicle.

III. METHODOLOGY

When the pedal is squeezed, the main brake engages and the car comes to a halt in the current system's backup braking mechanism in the event that the brakes fail. Nevertheless, if the main braking system fails and the wheel does not stop even after full use of the brake, an emergency situation has developed. As a result of his worry, the motorist in this scenario panics and applies more power to the pedal than is typical. The secondary braking mechanism is therefore activated when the pedal is depressed with a force much greater than the threshold. So, the secondary brake's activation is created in a manner that it activates when the pedal is pushed firmly. The suggested system is set up to demonstrate how a main braking system works first. After that, a brake failure scenario with indication is shown, at which point a backup braking system must immediately engage to bring the engine to a halt. Hence, a seamless switch from the main to the secondary braking system must occur immediately in the event of brake failures to prevent accidents. The secondary brake, which is used when the main brake fails, is being implemented in hardware with this project. To do the necessary computations and activities, the Arduino microcontroller is employed. Open-source hardware with minimal cost is called Arduino. To programme the hardware, utilise the C++ programming language. We set up a scenario in which the main brake of the car malfunctions, activating the secondary brake system. Accidents and serious injuries to the driver and passengers may be avoided as a result. The secondary brake is a braking system that is connected with the main brake such that when the primary brake fails, the secondary brake instantly engages and functions as a regular braking system. When the brake malfunctions, it first warns the driver and switches over immediately to the backup system.

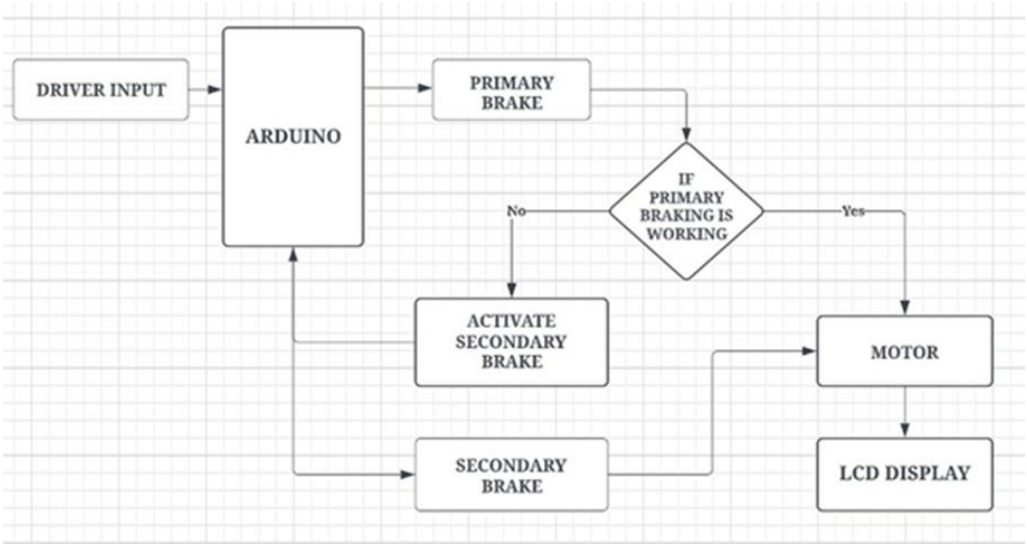

Fig. 1. Block Diagram of the proposed system

The block diagram of the proposed system is depicted in Fig. 1. The complete work flow can be summarized with the following actions;

- The input is sent to the Arduino when the brake is pressed. The main brake is turned on once the microcontroller calculates the brake signal. Moreover, it continually checks the wheels' braking pressure.
- An emergency situation develops if the wheel (or motor) fails not stop even after the main brake is fully applied.
- The microcontroller receives this data, and the driver also receives an alarm message.
- The secondary brake is then instantly activated by the microcontroller to prevent safety-critical situations.
- A closed circuit with a relay is set up for this actuation. Also, when the secondary brake engages, a lamp will illuminate to notify the driver that the main brake has failed and has to be replaced or fixed. Hence, incidents that often result from brake failure may be prevented by activating a secondary brake, which will apply the brakes.

The circuit diagram of the proposed work is as shown in Fig. 2. The major controlling component is an Arduino, Primary and secondary braking circuits are the two that we have devised. The control device will be continually updated with measurements of the voltage across the circuits. The motor driver on the Arduino is used to operate the wheel (motor) in response to the voltage input. For the wheels to halt, the voltage must be greater than the threshold voltage (4V). The driver provides the control unit with this input by depressing the brake pedal. When the main brake is engaged, the voltage across that circuit exceeds the necessary threshold voltage, causing the wheels to come to a halt. The secondary brake will be activated if the main brake fails or is broken, and voltage across this circuit will be transferred to the control unit, stopping the wheels.

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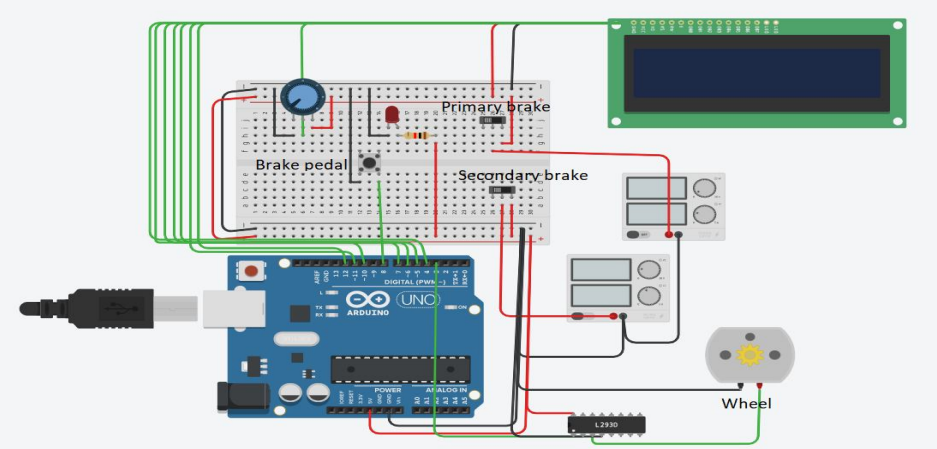

Fig. 2. Circuit diagram of the proposed system

Driver notification occurs when the secondary brake is applied. The wheels keep turning even when the voltage is less than the desired amount of 2V.

IV. RESULTS AND DISCUSSIONS

The results of the LC2BS model's testing at various speeds are described and examined in this section. With a low slip ratio, the results are good, attaining 95% correct braking. Brief explanations of the following numbers have been provided, indicating the work completed;

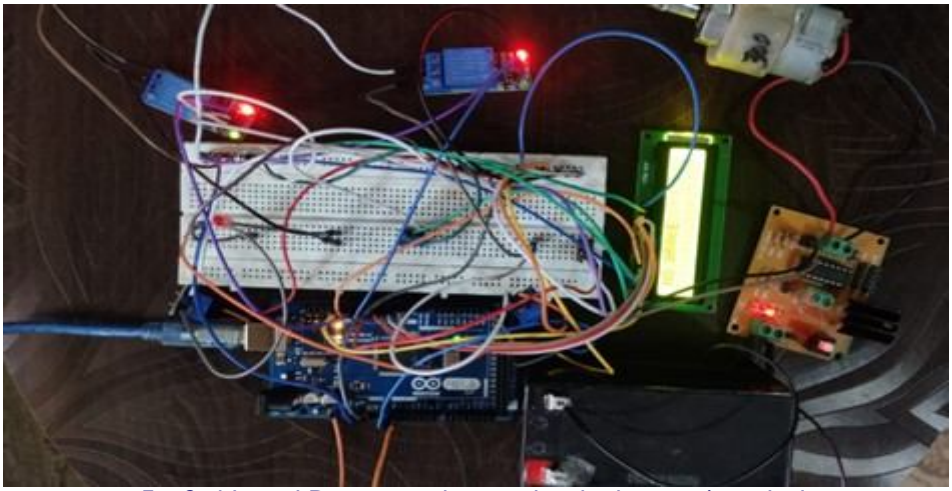

Fig. 3. Normal Driving conditions when brakes aren't applied.

Fig. 4. Output of Serial Monitor when brakes aren't applied.

When the brakes aren't deployed while driving normally, the car is in motion. The main and secondary brakes are left inactive and kept in reserve. We can verify the working of the motors – both relays are turned on, indicating the motion of the motors seen in Fig. 3. As a result, there is around 0V of voltage across the brake circuit which is verified from the Serial monitor in Fig. 4. On the application of brakes by the driver, the primary brakes are turned on and the voltage across the braking circuit is 5V. A Red LED on the left side of Fig. 5 depicts the application of brakes during critical times of emergency.

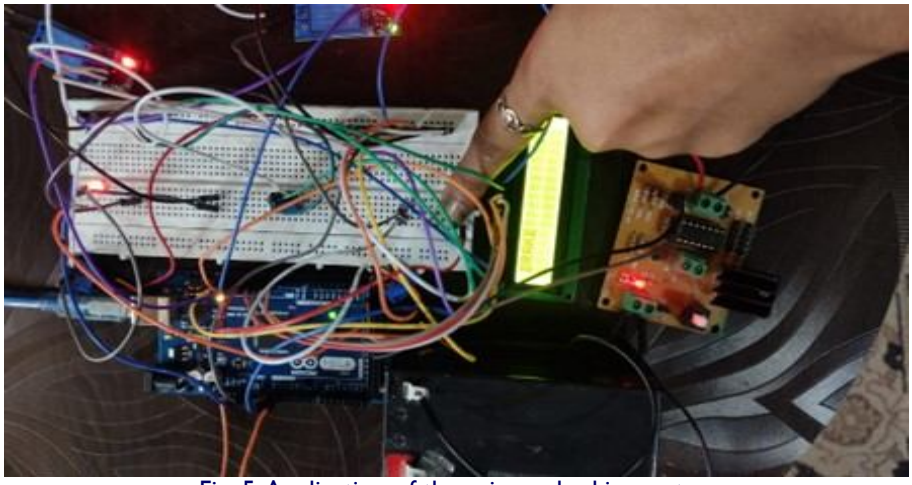

Fig. 5. Application of the primary braking system.

Fig. 6. Verification of application of primary brakes on the Serial monitor.

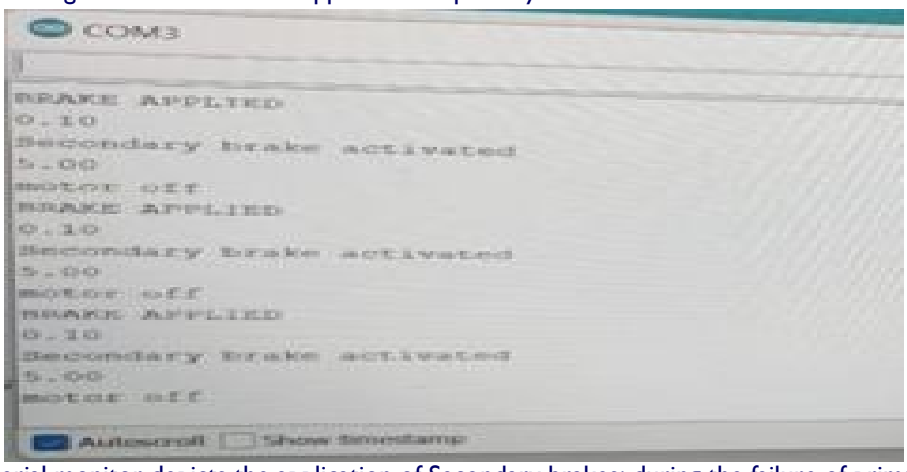

Fig. 7. Serial monitor depicts the application of Secondary brakes; during the failure of primary brakes

We can confirm that secondary braking is functioning from Fig. 7. In order to significantly lower the velocity and acceleration, the brakes are applied similarly to the ABS model, holding and releasing the brakes at regular intervals. The driver may then navigate safely, regulate the vehicle's steerability, and avert further dangers by doing so.

V. CONCLUSIONS

More control is provided to the driver through auxiliary braking, which also helps to protect people and property. Hence, the created system continuously assesses the state of the main brake and warns the driver in the event of brake failure. Also, an automated activation of the secondary brake circuit causes the car to come to a halt. The created system is a full-scale, robust prototype that can be incorporated into the current system and is designed to provide optimal passenger safety at a reasonable cost. In contrast to ABS and EBS systems, the designed system primarily focuses on driver and vehicle safety and is particularly cost-effective. As a prototype for light motor vehicles, the suggested system was created. It may be incorporated to big vehicles, such as buses and trucks, by altering a few system settings. By doing this, accidents in big cities or urban areas are prevented.

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