KOFORIDUA TECHNICAL UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF AUTOMOTIVE ENGINEERING

DESIGN AND INSTALLATION OF AN AUTOMATIC BRAKE FAILURE INDICATOR

SUBMITTED BY:

OBEDIENCE GAKPO	**B301210007**
RICHARD AMENU	**B301210011**
MORO HUDU MOHAMMED	**B301210021**

A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF AUTOMOTIVE ENGINEERING, IN THE FACULTY OF ENGINEERING KOFORIDUA TECHNICAL UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY CERTIFICATE (BTECH) IN AUTOMOTIVE ENGINEERING.

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STUDENT DECLARATION

We hereby declare that this project titled Design and Installation of an Automatic Brake Failure

Indicator is our work, based on our study and research under the supervision of Engineer Reverend George Bright Gyamfi from the Faculty of Engineering in the Department of Automotive Engineering in Koforidua Technical University.

We also certify that this project contains no material previously published or has beforehand been submitted for any assessment in any academic capacity, except due acknowledgment has been made in the text.

NAME	INDEX NUMBER	SIGNATURE
OBEDIENCE GAKPO	B301210007	……………
RICHARD AMENU	B301210011	……………
MORO HUDU MOHAMMED	B301210021	…………….

DATE 01 / 11 / 2023 .

SUPERVISOR'S CERTIFICATION

The undersigned certifies that the supervisor has read and recommended to the Faculty of Engineering for the acceptance of this research work entitled **DESIGN AND INSTALLATION OF AN AUTOMATIC BRAKE FAILURE INDICATOR.**

SIGNATURE………………………

DATE 02/10/2023……….

REV. EGNR. GEORGE BRIGHT GYAMFI

(SUPERVISOR)

SIGNATURE ………………….

DATE 02/11/23…………….

DR. CLEMENT NYAMEKYE

(HEAD OF DEPARTMENT AUTOMOTIVE ENGINEERING)

DEDICATION

This project is dedicated to God Almighty who has been our source of inspiration, wisdom, knowledge, and understanding. Also, to our families and lecturers for their encouragement and continuous support.

ACKNOWLEDGEMENT

Thanks to the Almighty God for the strength and ability he has given to us to carry out this project work successfully. Our special gratitude goes to our project supervisor Rev. George Bright Gyamfi a lecturer at Koforidua Technical University who guided us to finish this successful project. We would also like to acknowledge our families, friends and individuals for their efforts, encouragement and financial support.

To God be the Glory.

ABSTRACT

Increasingly, a growing number of people rely on vehicles for transportation in today's fast-paced world and this augmented dependency calls for the pressing need for improved road safety measures. Despite advancements in automotive technology, brake failures persist as a significant threat on the roads, leading to numerous accidents and fatalities worldwide**.** As a way to address this critical concern, this project aimed at the design and installation of an automatic brake failure indicator for vehicles which emerges as a pivotal innovation to revolutionize the automotive safety system. A brake failure indicator is a technologically advanced safety device that automatically detects potential braking system malfunctions or deficiencies in the system, providing drivers with audible warning signals. The project entails the integration of mechanical, electrical, and software engineering principles to develop a reliable system. The automatic brake failure indicator assumes significance by providing an additional layer of protection against brake failures that could lead to accidents. The study phase to realize this project was put into five parts, the first part consisted of the literature review of the already existing system. Then the mechanical phase including the various parts needed for the system was defined and general analysis strategies were formulated. Using adequate software, the **Proteus** was employed for the design of the circuit and **Arduino IDE** for the system programming. The second part entails a detailed overview of the braking system components and the last part of the project was the step-by-step analysis of the system and then the assembly of the components and tests were done, and then the discussion of the results was obtained from the test run to ascertain the success of the project.

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CHAPTER ONE - INTRODUCTION

Introduction

This chapter provides details on the background of the research, the problem statement, the objectives, and the scope of the research relating to vehicle safety enhancement and accident prevention using technological sensors like microcontrollers and audio warning systems. This section also talks about the significance and organization of the study.

1.0 Research Background

The vehicle's braking system is undeniably its most important safety feature as it ensures that a moving vehicle can come to a complete halt efficiently and reliably and it is also responsible for retarding the speed of a vehicle in any given situation. Brake failure is a distressing scenario that can adversely affect both the driver and other road users. (Coelingh, Jakobsson et al. 2007) This occurs when the braking system of a vehicle experiences a breakdown and loses its primary function- the ability to slow down a moving vehicle or bring a vehicle to a stop.

Brake failure can result from mechanical failure within the braking system (Entezami, Hillmansen et al. 2012). This can include issues like brake fluid leaks, malfunctioning calipers, or broken brake lines. When brake fluid leaks, hydraulic pressure decreases, resulting in less braking force applied to the wheels. Defective calipers and worn brake pads can compromise the effectiveness of the braking system (Popa, Capătă, et al. 2021), resulting in longer stopping distances when the brakes are applied.

The notion of an automatic brake failure indicator circles a vibrant aspect of vehicle safety systems (Denton 2016), the braking system in a world where vehicular accidents can arise due to several reasons, a malfunctioning brake system is an alarming concern

(Martinez, Toh et al. 2010). The purpose of this work is to design an automatic brake failure indicator that can detect potential disasters with the help of sensors and will be able to provide immediate alert to drivers in the unfortunate event of brake failure, enabling them to take prompt actions to prevent accidents on the roads.

The automatic brake failure indicator is an essential component for ensuring the safety and functionality of vehicles (Limpert 2011), as it addresses a crucial concern for both drivers, passengers and pedestrians on the road. Designing an automatic brake failure indicator involves mechanical, electrical, and software engineering (Juvinall and Marshek 2020). The system is typically integrated with the vehicle's existing braking system to monitor the hydraulic pressure, pedal position, wheel speed, and hydraulic pressure, among others. An audible warning indicator is activated when any of these parameters diverges from the standard functionality of the system (Dong, Hu et al. 2010).

1.1. Problem Statements

In the automotive safety context, keeping the braking system in good working order is of a primary concern where automobiles rely heavily on the reliable operation of the braking system.

Below is the problem statement of our research study;

- The detection of braking system anomalies in a timely manner still remains a challenge for most drivers despite the advancements in vehicle engineering.
- The traditional brake failure indication system relies on manual assessments by the drivers; thus, the driver is responsible for observing the day-to-day operation of the braking system. This system however, susceptible to human error or distractions.

- The current brake failure indicators often rely on manual checks and limited warning systems which may be ineffective or unreliable in providing early detection of the braking system malfunctions.

1.2 Aim and Objectives

- To design an automatic brake failure indicator system
- To install an audible warning indicator into the existing braking system of a vehicle
- To retrofit the vehicle braking system

1.3 Significance of the Research

- To minimize road accidents and collisions due to brake failures.
- For protection of lives
- To enhance driver awareness
- To improve automotive safety
- To ensure reliable detection and communication to the driver
- To continuously monitor the day-to-day working condition of the braking system of a vehicle.

1.4 Scope

This project is limited to the braking system of cars.

1.5 Organization of the Research

This work is organized into five (5) chapters. Whereas the chapter one of the research consist of a general introduction outlining the research background, the problem statement, objectives, its significance, scope, limitations and organizational structure of the research work. In the second chapter, we reviewed relevant literature related to our research area and presented a brief theoretical framework. Also, a detailed description of the methodology or approach followed for achieving the objectives of the research is provided in the third chapter. In the fourth chapter, the analysis of the research results is discussed, along with the valid bases on which these results were reached. Finally, the chapter five (5) provides conclusions and recommendations for future research studies.

CHAPTER TWO – LITERATURE REVIEW

Introduction

This chapter discusses the literature review on the vehicle braking system, the types, parts and the working principle of the braking system for better understanding of the research work.

2.0. Literature Review

As vehicle technology increased with vehicle speed over the years, so as the safety technology needed to safely stop or retard these vehicles speed must also evolve (Hancock, Lesch et al. 2003). It is no secret that the braking system has undergone several changes throughout history from lever brakes used in horse carriages to air brakes used on high-speed cars (Heitmann 2018), the technology used to propel vehicles to high speed has caught the society's attention, but not as same as the evolution of the braking system (Bengler, Dietmayer et al. 2014).

In the early years, brakes were originally external brakes utilized by horse carriages through a lever mechanism that brought rubber pads into contact with the axle (Heißing and Ersoy 2010).

The braking system of automobiles date back to the 19th century (Savaresi and Tanelli 2010). Automotive brakes began with wooden block brakes. it was not until 1899 that Gottlieb Daimler came up with a new idea for brakes, mechanical drum brakes (Eckermann 2001). In 1902, a study about the history of the vehicle braking system by Ahshat Sharma Amit Kumar Marwah brought to light of a major test of the early brakes in the city of New York where Ranson

E. Olds wanted to test a new brake system against the internal drum brake and a tyre brake of a Victoria horseless carriage. His reason be that he wanted to be certain if the external drum brake would match the expanding shoe drum design of Victoria and the tyre brake of the coach- a lever operated pad that was applied to the tyre by a long lever. At a long run, the internal brake overcame the problems related to the external brakes. In the same year F.W. Lanchester invented a nonelectric spot disc brake system that has the same working principle as what we have today.

One on the challenges Lanchester face was noise pollution caused by the contact between the copper linings and the metal disc (Lancaster 1980). Another English man, Herbert Frood solved the problem in 1907 by proposing the idea of lining pads with asbestos. Automobile manufacturers realized the need for an improvement in the braking technology as road infrastructure advanced and the speed at which cars were driven increased (Bengler, Dietmayer et al. 2014).

According to T.P Newcomb, 1981, in his article of the development of the vehicle braking system he talked about the overview of the development pattern up to present day highlighting the resemblance between the past and the present and comments on the future. He divides development event into three periods pre-1914, the inter-war period and post 1945. The author specified that the early brakes were based on existing bicycle or horse carriages brakes and was not long before it went out of style, and by 1914 external hand brakes became the most common typically used on rear wheels. In 1931 four-wheels brake became obligatory. Approximately half of the vehicles manufactured in 1934 were equipped with hydraulic braking systems this led to the creation of brake companies such as Girling, Bendix and Lockheed. Friction materials were continually improved, and molded linings using thermos-setting resins were developed.

In his conclusion he predicts that brake systems will not undergo any radical change but the system will be refined and to meet future elements and recued weight and reduced maintenance.

Early discs brakes were developed in 1960 due to excellent performance on racing cars, low- cost servos, and the obtainability of good, reliable servos. However, most vehicles continued to use drum brakes on the front and rear. The developers of the various brake systems shared a common overarching goal: to make motor driving easier. The quest for enhanced road safety persists into the 21st century. By exploring the history of the brakes and its present-day version, we gained an understanding of how far this technology has travelled.

2.1. Review Theory

Through thorough research, reading and analysis of previous works we discovered that the development of the braking system as it is the most crucial aspect of the system safety when it comes to automotive manufacturing industry is of a paramount important. The various works done shows that since brake failure can result in catastrophic consequences, researchers and engineers have explored variety of methods and technologies to develop a reliable and effective automatic brake failure indicator to ensure the safety of vehicle users and road users.

2.2. The Principle of the Braking System

(Limpert 2011) a brake is a series of specialized devices used in the car to exert a certain force on the outside (mainly the road) in certain parts of the car (mainly the wheels). Automobiles have been equipped with many vital safety systems of which the braking system holds the utmost importance in retarding the speed of the wheels and eventually stopping it (Reif 2014) and also prevent accidents and ensures the safety of drivers and other road users. It is estimated that averagely a driver uses the brakes seventy-five thousand (75,000) times a year making the brakes one the most vital and overworked vehicle system. During the braking the process, the pads or shoes presses against the drum or the rotating rotor converting kinetic energy to thermal energy through friction (Orthwein 2004). The dissipation of the heat which allows for cooling of the rotor effectively stops the wheels. This process is referred to as the first law of thermodynamics which states that energy can neither be destroyed nor created (Gyftopoulos and Beretta 2005).

There are several types of brakes but the most widely used and implemented in cars are the disc and drum brakes (Limpert 2011). Basically, the brakes are the components of the vehicle that stops or slows the motion of the rotating wheels using friction materials in the form of pads or shoes hard-pressed against the wheels (Burton 2013).

(Kosko and Isaka 1993) A rapid brake application causes the whole brake assembly to be hot and would not get the chance to cool off. Due to so much heat buildup in the system the braking efficiency automatically drops which could result in road accident (Limpert 2011). During the braking event, as the driver's foot presses the brake pedal the cars braking system transmits the pedal force to the brakes via the brake fluid. Since the brake system requires a much greater force than the foot or pedal force applied to stop the car, the brake component called the vacuum booster multiplies the pedal force which was exerted by the driver (Reif 2014). The brakes use friction to transmit the braking power to the tyres whereas the tyres also transfer that power to the road by friction (Zegelaar 1998).

The figure 1 illustrates a typical automotive brake system circuit comprising the disc and the drum brakes in the front and rear respectively which are linked together with a system of tubes and hoses that connect the brake at each wheel to the master cylinder.

(Jung, Jun et al. 2008) Parking brakes, power or vacuum brake boosters, and anti-lock systems are connected to the brake system, when the brake pedal is depressed, a plunger in the master cylinder pressurizes the hydraulic fluid (brake fluid) through the system of tubes and hoses to the braking unit at each wheel for the wheels or rotor to hold (Ho 2015). Without a proper attention, the braking system which is a very crucial safety system in the car that plays a pivotal role in ensuring road safety would possibly lead to road accident if this essential system is neglected.

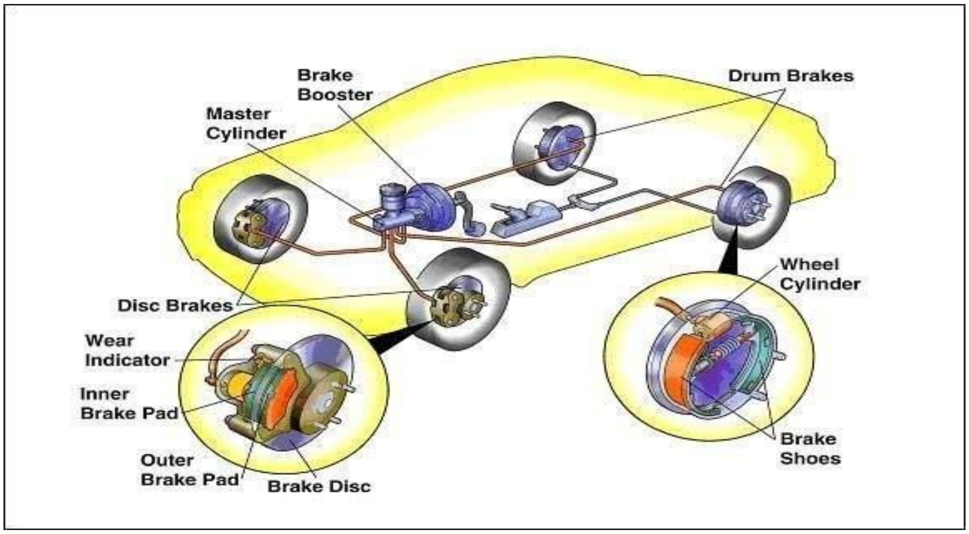

Figure 2. 1 Typical Automotive Braking System

2.2.1. Types of Braking Systems

2.2.2. Wooden Block Brakes

When braking system were invented it only consisted of a wooden block and a lever. Driven vehicles were brought to a halt by the block of wood grinding against the wheels as they were been pulled. As a result of this type of brake technology, horse-drawn carriages and steam powered cars had stee- rimmed wheels during that time.

(Simpson 2002) the first automobile to use pneumatic rubber tyres. Wood blocks became obsolete when rubber tyres became popular.

Figure 2. 2 Early Type of Brakes Used on Horse Carriages and Automobiles

2.2.3. Mechanical Drum Brakes

The early type of brakes had been outside the vehicles. The drum brake was the first system to be fastened inside the vehicle (Reif 2014). The internal shoe brake added a new vital element: the placement of the brake inside the automobile. These brakes are primarily used on wheels, although they are sometimes found on cranes as well (Orthwein 2004). With such brakes a vehicle axle is attached to a backing plate or brake shield that supports the brake shoes and brake-operating mechanism (Newcomb 1981). Even though Gotlieb Daimler invented the drum brake in 1902,

French manufacturer Louis Renault is widely credited as the first manufacturer of drum brakes.

He lined the drum brake with woven asbestos since no alternative dissipated heat like asbestos.

Originally, drum brakes were operated with levers and rods or cables. In the mid 1930's a wheel cylinder, oil pressure and a piston were used to operate the brakes yet some cars operated mechanically (Genta, Morello et al. 2014).

The drum brake consists of a set of friction shoes pressing against a rotating drum-shaped part known as the brake drum to brake a car. (Parker and Newcomb 1964) Drum brake shoes wear thinner and need to be adjusted periodically until self-adjusting drum brakes were introduced in the 1950s. Since 1960s-and 1970s-disc brakes have gradually replaced drum brakes on the front wheels of cars. In most cases disc brakes are used on all the wheels on cars (Parker and Newcomb 1964). In comparison to wooden block braking system, drum brakes marked an improvement in responsiveness. While manufacturers have made ground-breaking changes, they recognized that technology still needs to be further advanced (Roberts 1988). Drum brakes were prone to environmental factors like heat, dust, snow, and water, which compromised their effectiveness.

This was a result of the fact that drum brakes were externally exposed (Gaier 2007).

2.2.4. Disc Brakes

Prior to the 1950s, this system had existed for decades and got patent in 1902 by William Lanchester. Disc brake work by generating friction by pushing brake pads against a brake disc with a set of calipers on the wheel to slow or stop the rotation (Parker and

Newcomb 1964). Brake disc is usually cast iron although in some cases they may be composed reinforced carbon-carbon or ceramic matrix composites (Devi and Rao 1993). This is connected to the master cylinder or axle of the vehicle. (Miller 2010) The brake pads are mounted in the clamps of the brake calipers, when the brakes are applied, brake fluid filled in the master cylinder is pressurized and creates pressure in the piston inside the caliper, which intend forces the pads mechanically, hydraulically, pneumatically or electromagnetically against the rotor or the wheel to retard its rotation and to stop the wheel when needed.

2.2.5 Air Brakes System

Air brakes are technically known as compressed air brake system, they are the type of friction brake for automobiles which uses compressed air to apply pressure on the pads to stop a rotating wheel the brakes or decrease its speed (Shi 2016). Air brakes are employed in large, heavy vehicles especially those with multiple trailers that need to be connected to the braking system, like trucks, buses, trailers and semi-trailers. George Westinghouse was the first inventor to invent the air brakes to be utilized on railroad applications. On march 5, 1872 Westinghouse was granted patent for his invention of the air brake system which he made numerous changes to his invention that led to the various forms of automatic brakes. During the early 20th century after its benefits had been proven in the railway services, truck manufacturers and heavy road vehicle manufacturers adopted the system (Geels 2005).

2.2.6. Electromagnetic Brake

(Seshia 2002) Electromagnetic brakes functions through electrical means wile transferring torque mechanically expediting to their historical designation as an electro-mechanical brake. As time progressed, these brakes acquired the name “electromagnetic” due to the emphasis on their actuation method (Carlson 2013). In more than six decades, since the prevalent adoption of brakes we have witnessed an extensive flow in both the range of applications and the diversity of brake project.

However, the central principle of operation has endured with single face electromagnetic brakes instituting a notable 80% of power-applied brake applications (Hauer and DeSteese 2004).

Electromagnetic brakes have traditionally served as supporting deceleration mechanisms alongside the standard friction brakes in heavy duty vehicles (Petrescu 2020). Eddy current brakes and electromagnetic brakes both use electromagnetic force to operate, but the electromagnetic brake solely rely on friction whiles the Eddy current brakes directly depends on magnetic force. A variety of design invention have enabled electromagnetic brakes to be applied to aircraft applications a combination motor or generator is used as a motor to spin the tyres up to speed before touchdown to reduce tyre wear and again used as generator to regenerative brake the aircraft.

2.3. Main Components of the Braking System

2.3.1. Brake Disc

The brake disc also referred to as brake rotor, revolves in conjunction with the wheel. It undergoes deceleration by the application of the brake pads which are composed of friction material (Reif 2014). These brake pads are positioned on either side of the rotor and are pressed against it with the help of piston forming the pressure mechanism. As a result, the rotational motion of the disc is gradually reduced leading to the deceleration of the entire wheel, ultimately contributing to the slowing down and eventual halting of the vehicle (Jacobsson 2003).

Figure 2. 3 Brake Disc

2.3.2. Drum Brake

A drum brake is a braking system that relies on the generation of friction. This friction is produced when a set of shoes or pads exerts an outward force against a cylindrical component known as drum as brake drum which is in the state of rotation (Orthwein 2004).

Figure 2. 4 Drum Brake

2.2.3. Master Cylinder

The brake master cylinder serves as a mechanism that converts the pedal force applied by the driver into hydraulic pressure which subsequently actuates the motion of the calipers

(Gerdes and Hedrick 1999). The master cylinder is usually situated in proximity of the brake pedal and is connected to the pedal via a push rod. When the brake pedal is engaged, the push rod exerts pressure on the piston inside the master cylinder, initiating the flow of the brake fluid through the brake lines and then to the calipers. This hydraulic action is what facilitate the vehicle's braking process.

Figure 2. 5 Brake Master Cylinder

2.3.4. Brake Calipers

The brake calipers functions as an enclosure for the brake pads and plays a key role in converting hydraulic pressure into mechanical force (Lundin 2015). When the driver applies pressure on the pedal the hydraulic pressure originating from the master is conveyed to the caliper, as the hydraulic pressure reaches the caliper it enters the housing and acts upon the pistons within it. These pistons respond to the hydraulic force by moving outward from their initial positions within the caliper housing. The outward motion is what initiates the mechanical force required for the braking process (Sclater 2011).

Figure 2. 6 Brake Caliper

2.3.5. Brake Pads

Brake pads are slender block composed of a steel backing plate with a friction material bound on the surface that faces the disc or normally used in the disc braking system. It is designed to apply pressure onto the disc with the primary purpose of reducing the speed or halting a vehicle by converting kinetic energy into thermal energy through friction.

Figure 2. 7 Brake Pads

2.3.6. Brake Reservoir

The reservoir is a canister mounted on the master cylinder which stores the brake fluid.

Figure 2. 8 Fluid Reservoir

CHAPTER THREE – MATERIALS AND METHODOLOGY

Introduction

This chapter explains the methods used in data gathering and analysis, which involves the systematic collection, analysis, and interpretation of data. The chapter also focusses on the various tools and materials that have been employed in gathering data for the research work.

3.0. Materials and Methodology

3.1. Design of Experiment

During the design process, the materials and tools needed for the experiment was identified. The use of a circuit diagram was also employed to help determine the right wiring structure. This work was constructed using only simple and readily available components, which include the car braking precisely the drum brake, a buzzer and a control unit which is the microcontroller we used.

3.2. Equipment and Specifications

3.2.1. Metal Frame

Figure 3. 1 Image of Square Pipe frames

Figure 3.1 shows a metal frame or pipes made of mild steel bars that are suitable, slightly stressed components. The square pipes are an extruded products used for fabrication projects where lightweight and corrosion resistance are primary concerns. It has a smooth interior and no layers. For higher precision applications, it is available in extruded structural or drawn seamless tubes. There are no additives added to improve mechanical or machining properties. Bright drawn mild steel is a superior quality material, free of scale, cold worked (drawn or rolled) to size, and is dimensionally accurate.

3.2.2 Battery

The battery pack appears to be the only technically and economically feasible means of optimizing the overall system according to the availability of energy and local demand

Figure 3. 2 18650 Lithium Ion Battery

pattern. 18650 battery is a rechargeable lithium-ion battery composed of electrolytes that have a voltage of 3.6 volts and a capacity of 2600mAh- 3500mAh (milliamp hours). The name comes from how large the battery is: 18×65mm.

3.2.3. Resistors

Essentially, resistors are passive components that impede electric current flow in an electronic circuit. They are used to control the current, voltage and power levels. The fundamental unit of resistance is the ohm, the higher the resistance value the greater the restriction of current flow. When it comes to automotive engineering, it is essential to select the right type and value of resistors. The resistance value is chosen based on the desired current flow and the circuit's specific requirements. The resistor's power rating is important to avoid overheating and failure, especially in applications that involve high

Figure 3. 3 Resistor

currents or voltage drop.

3.2.4. Buzzer

A buzzer is an electric device that converts electrical energy into sound. It consists of a coil of wire and a diaphragm, which typically made of metal or plastic. When an electrical current passes through it, a magnetic field is created that causes the diaphragm to vibrate which intends produces sound wave. Buzzers are mostly used in vehicles to provide audible warnings to drivers

The choice of buzzer has a significant effect on the user's experience. A buzzer may be more suitable for applications that require a loud and consistent alarm, while others may be preferred for their energy and compactness.

Figure 3. 4 Buzzer

3.2.5. Perforated Board (Perf' Board)

Perforated board is a type of circuit board usually made of a rigid material, such as fiberglass, with holes drilled through it. It is mostly used for prototyping and building electronic circuits. The holes are drilled and aligned in rows and columns to pave way

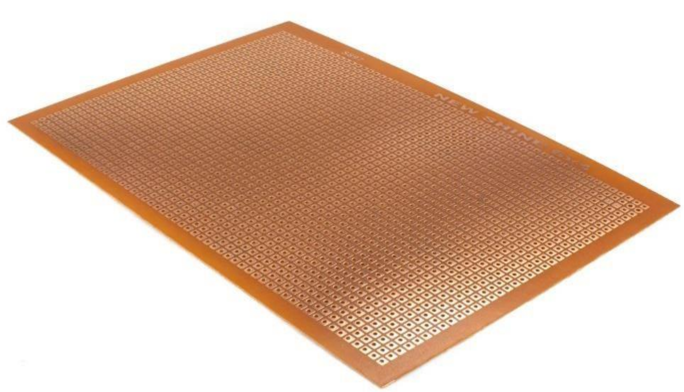

Figure 3. 5 Perforated Bread Board

for easy soldering and interconnect the electronic components to create custom circuits.

3.2.6. Terminal Blocks

This type of blocks is modular and has an insulated frame that secures two or more wires together. It is also referred to as extension terminal or terminal connector. The simplest terminal block consists of a clamping component and a conductor.

In a terminal block, the insulating body contains a current carrying element (metal strip or terminal bar). Besides providing a base for clamping elements, the body is also equipped with a mounting arrangement that makes it easy to mount or unmount blocks from PCB or mounting rail. This allows for increase or decrease terminal numbers according to requirements. Terminal blocks keeps connection much more secure and wires well organized.

3.2.7. Drum Brake System

Drum brakes are the type of braking system commonly used in vehicles; it is mostly found at the rear of cars they consist of cylindrical drums attached to the wheels within which brake shoes are found. When the brakes are engaged the brake shoes are forced against the inner surface of the drum creating friction that slows or stops the car.

Figure 3. 6 Drum Brake System

3.2.8. Dc Jack

In electronics devices, DC power jacks are used to receive power and are usually found on the PCB or chassis. DC power receptacles are also designed to receive power and are usually found at the end of a power cable

Figure 3. 7 DC Power Jack

3.2.9. Sensor and Selection

A wide array of ultrasonic sensors is accessible, each varying in terms of frequency and power consumption. Ultrasonic sensors operating at higher frequencies exhibits a narrower beam width enabling them to detect obstacles at an extended distance. However, some newer models offer comparable detection ranges to their predecessors while consuming less power. For this project it is imperative that the ultrasonic sensor has the capability to detect obstacles within a range spanning from 2 centimeters to 400 centimeters.

In view of the fact that the whole system will be powered by batteries the low current consumption is crucial along with the ability to operate at low voltage is of utmost importance. In long-term research between HC-SR04 and other ultrasonic sensors, the HC-SR04 meets the criteria of our project to detect the obstructions quickly.

3.2.10. Microcontroller (Arduino)

The project is based on microcontroller board which provide sets of digital and analog input and output pins that can interface to numerous expansion boards and other circuits. these system Microcontrollers are compact integrated circuits (ICs) that have a processor core, memory, input/output peripherals, and communication interfaces which in certain models incorporate universal serial bus (USB) option for transferring programming codes. Arduinos are digital and interactive devices that can sense and actuate or control physical devices. They are often used in embedded systems to perform specific task. A microcontroller is used in variety of applications in automotive systems, including engine control units (ECUs), transmission control units (TCUs), anti-lock brake systems (ABS), and airbag control units.

A vehicle's electronic system's performance and functionality are directly impacted by the selection of a microcontroller in automotive design. In order to meet the requirements of a specific application, processing speed, memory, and input/output pin count need to be carefully considered. The project is based on microcontrollers

3.2.11. The HC-SR04 Ultrasonic Sensor

A wide array of ultrasonic sensors is accessible, each varying in terms of frequency and power consumption. Ultrasonic sensors operating at higher frequencies exhibits a narrower beam width enabling them to detect obstacles at an extended distance. However, some newer models offer comparable detection ranges to their predecessors while consuming less power. For this project it is imperative that the ultrasonic sensor has the capability to detect obstacles within a range spanning from 2 centimeters to 400 centimeters.

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3.2.12. HC-SR04 Ultrasonic Sensor Features

Introducing the HC-SR04 ultrasonic distant sensor. This cost-effective sensor delivers noncontact measurement capabilities ranging from 2 centimeters to 400 centimeters, boasting impressive ranging accuracy, accurate to within 3 millimeters. Each HC-SR04 model comprises an ultrasonic transmitter, a receiver, and a dedicated control circuit.

3.2.13. Basic Principles of HC-SR04 Ultrasonic Sensor:

- Utilizes 10 trigger to receive a signal for at least 10 microseconds
- Initially the model sends eight 40 kHz signals and detect whether they are returned with a pulse.
- When an ultrasonic signal returns by high level, the time of the high output or input duration is the total time from sending the ultrasonic signal to receiving it.

3.2.14. Pin Configuration of the Ultrasonic Sensor.

1. 5 volts power supply
2. Trigger pulse for input signal
3. Echo pulse for output signal
4. Ground for 0 volts signal

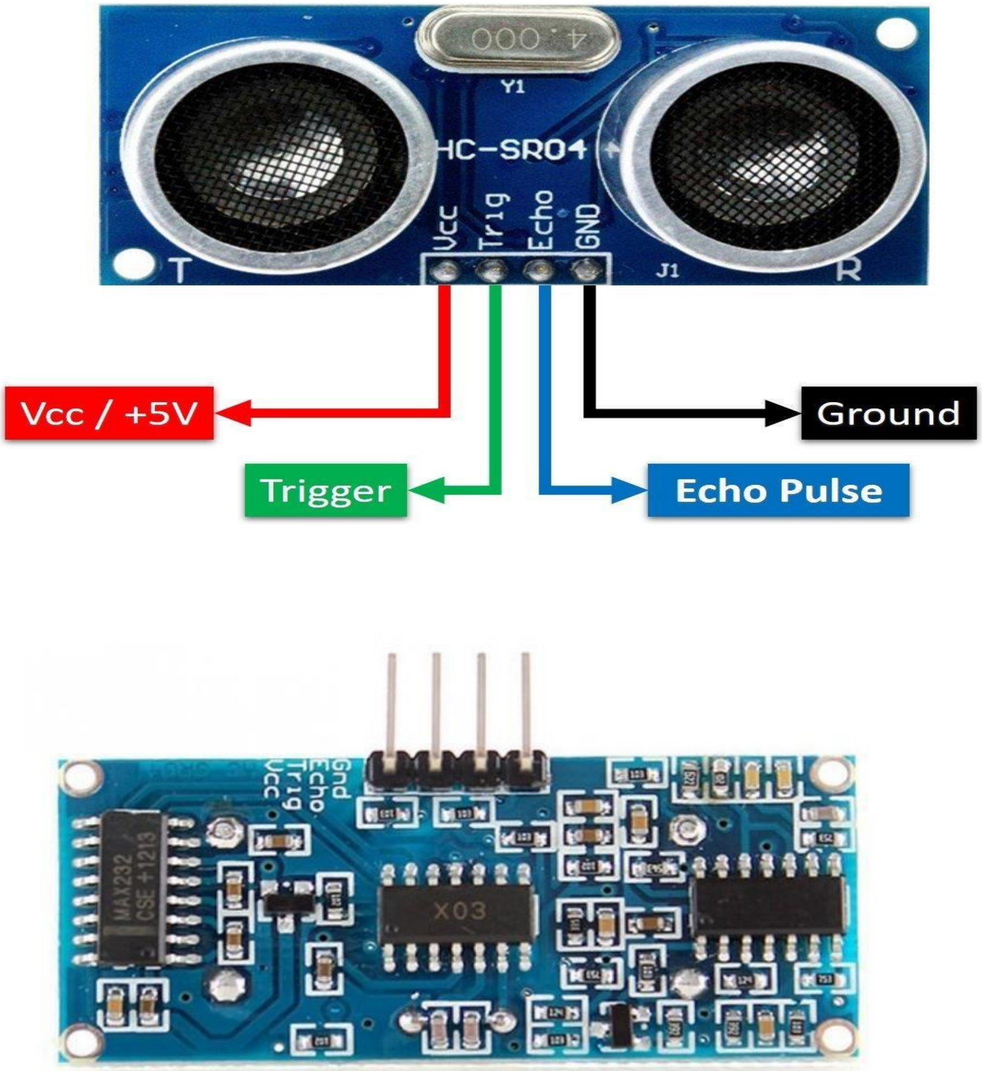

Figure 3. 8 Pin Configuration of the Ultrasonic Sensor

3.3. Arduino Uno

The Arduino UNO represents the microcontroller board that centers around the ATmega 238 microchip as its core component. This versatile board is equipped with an array of features, including the 14 digital input and output pins with the capability for 6 of them to function as pulse width modulation (PWM) outputs. Furthermore, it accommodates six analog inputs, integrating 16 MHz crystal oscillator to ensure precise timing. To facilitate connectivity, it offers USB connection along with a power jack for external power supply. Additionally, it is designed with an in-circuit serial programming (ICSP), header and a reset button, providing a user-friendly and versatile platform for various electronic and microcontroller-based projects

3.3.1. Features of the Arduino Board

3.3.2 Headers

In electronics, headers are connectors consisting of one or more of pins. The connectors come in two forms male (pin) or female (socket) and they are often used on printed circuit boards (PCBs), the headers also referred to as the two lines as socket that are aligned with the board edges. Through the sockets you can connect wires to all sort of electronic devices including

LEDS, displays, sensors or motors.

3.3.3. Header Pins or Connectors

3.3.4. The Power Header

It is located in the middle bottom of the board. This enables you to connect power to the pins or borrow power from the USB or DC jack and use it to drive motors, sensors and any other electronic device.

3.3.5. Power Header Labels

VIN; As this is connected to the DC its voltage ranges from 7V to 12VDC depending on the component plugged to it. If the DC is not powered it produces 5V from the USB interface.

GND; The GND are the common ground connections for all power and data.

5V; The arduino runs on this 5V regulated power provided by the DC jack (if connected) or the USB (if not connected). It supports up to 500mA of current.

3.3V; For some sensors you will need exactly this voltage for it. It supports up to 100mA current draw.

Digital pin headers; The top of the board is covered with two digital pin headers. These are used to connect complex components or control relays, blink LEDs, listen for switches. They use 5volts for high signals and 0 volt for lower signals.

Analog Pin Headers; The analog pins are special input pins on the board that can read sensors. Each pin can read voltage between 0 and 5.

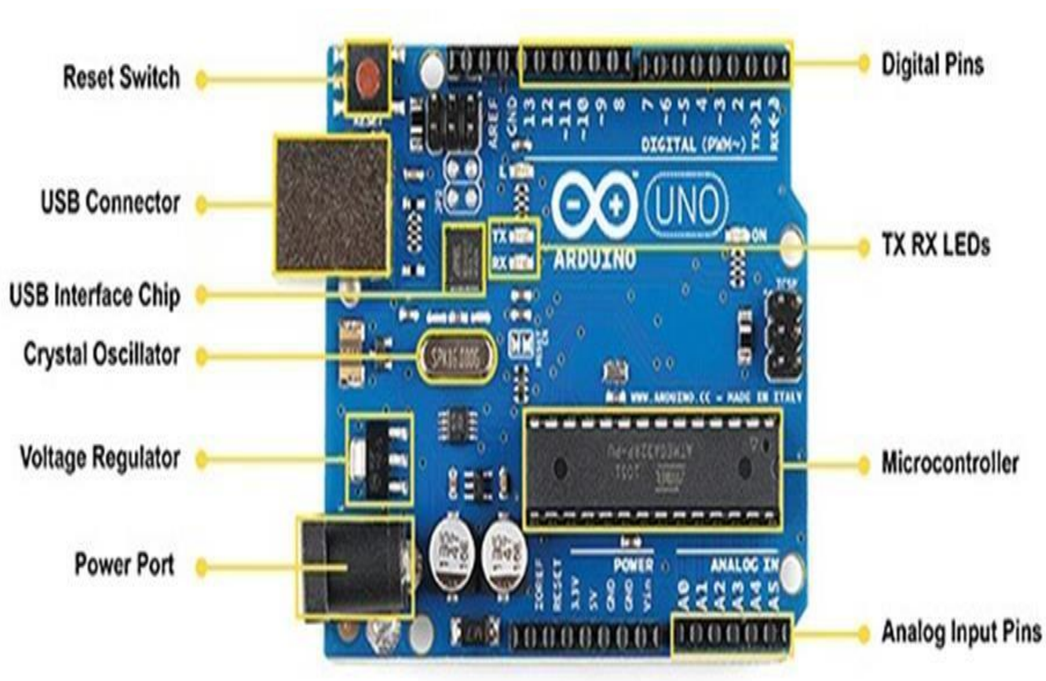

Figure 3. 9 Arduino Uno

3.4. Materials/ Part List and Cost

In order to build the model, a systematic plan is developed that involves seven steps process. As shown in table: 3.1, a bill of materials (BOM) is a formal and comprehensive documentation of the specific items that must be included in a finished product that has to be completed.

Table 3. 1 Cost of Material/Part List

S.NO	DESCRIPTION	QUANTITY	UNIT PRICE (GH₵)	MATERIAL
1	Metal Pipes/ Frame	1		Mild Steel
2	Controller	1	130	Electrical
3	Headers	1	10	Electrical
4	18650 Battery	1	50	Electrical
5	Holder	1	25	Electrical
6	Resistors	1	2	Electrical
7	Buzzer	1	5	Electrical
8	Perf' Board	1	20	Electrical
9	Terminal Blocks	1	10	Electrical
10	Case	1	250	
11	Drum Brake System	1		Mechanical
12	Dc Jack	1	5	
13	Ultrasonic Sensor	1	70	Electronics

3.5. Methods Used

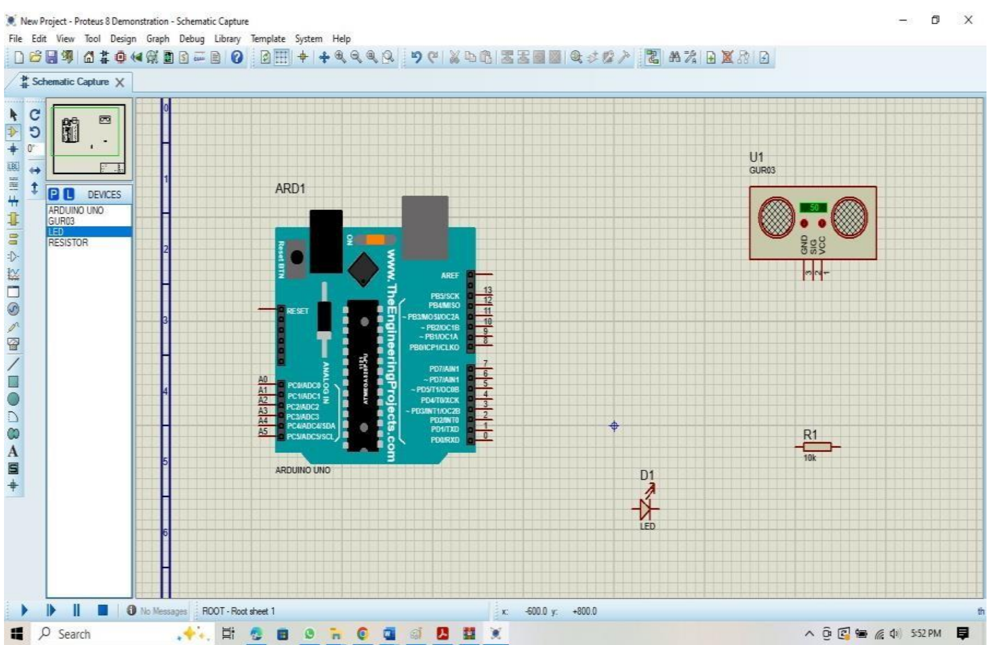

Figure 3. 10 Selection of Components Using the Proteus Software

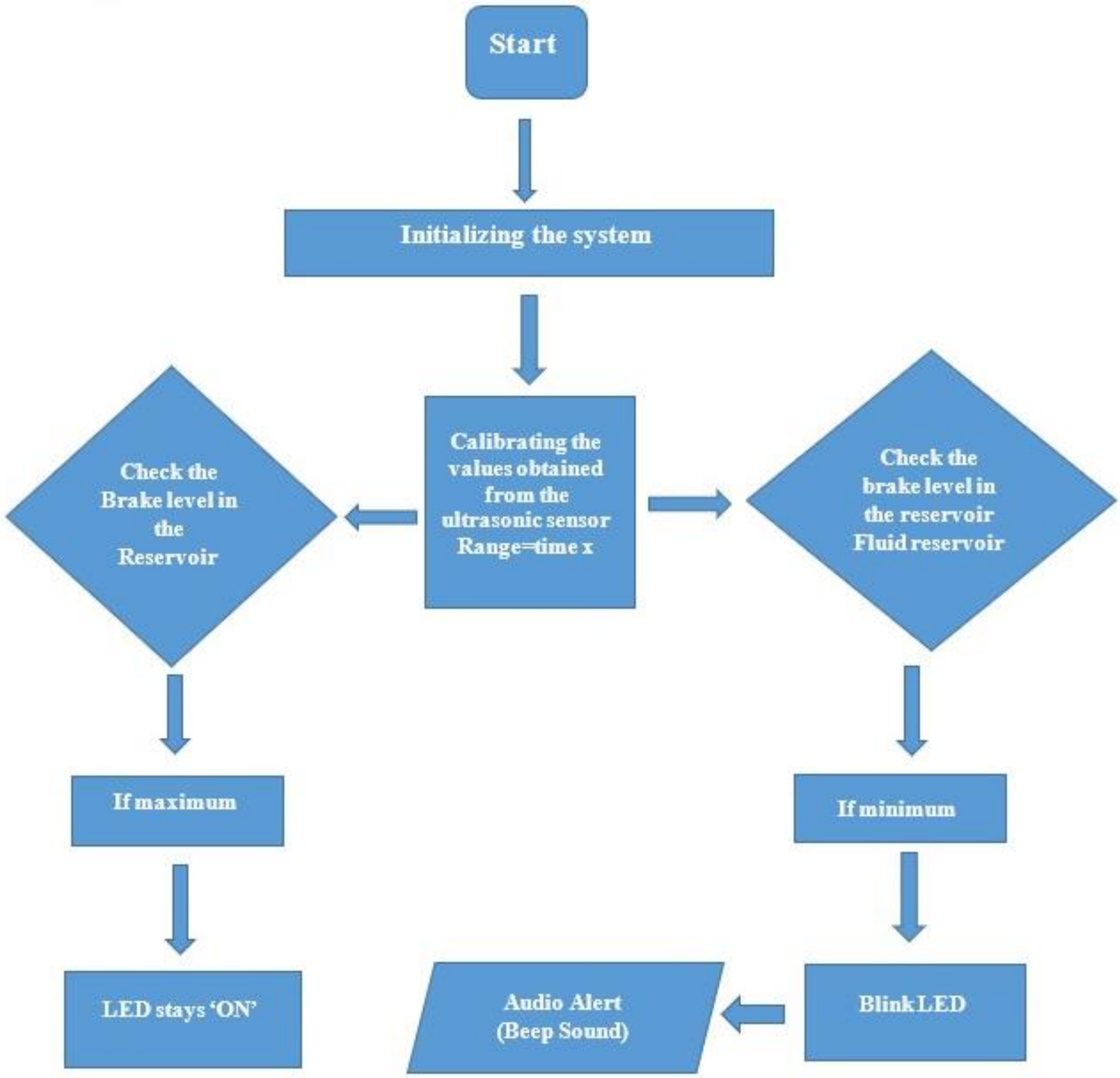

Figure 3. 11 Block Diagram of Installed Materials

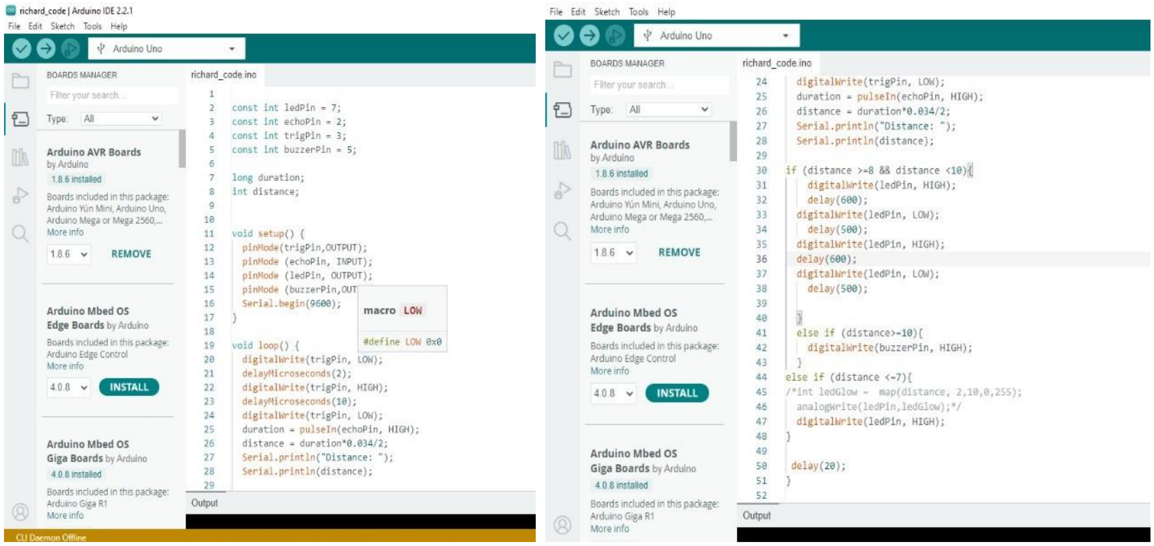

Figure 3. 12 Programming Using Arduino IDE Software

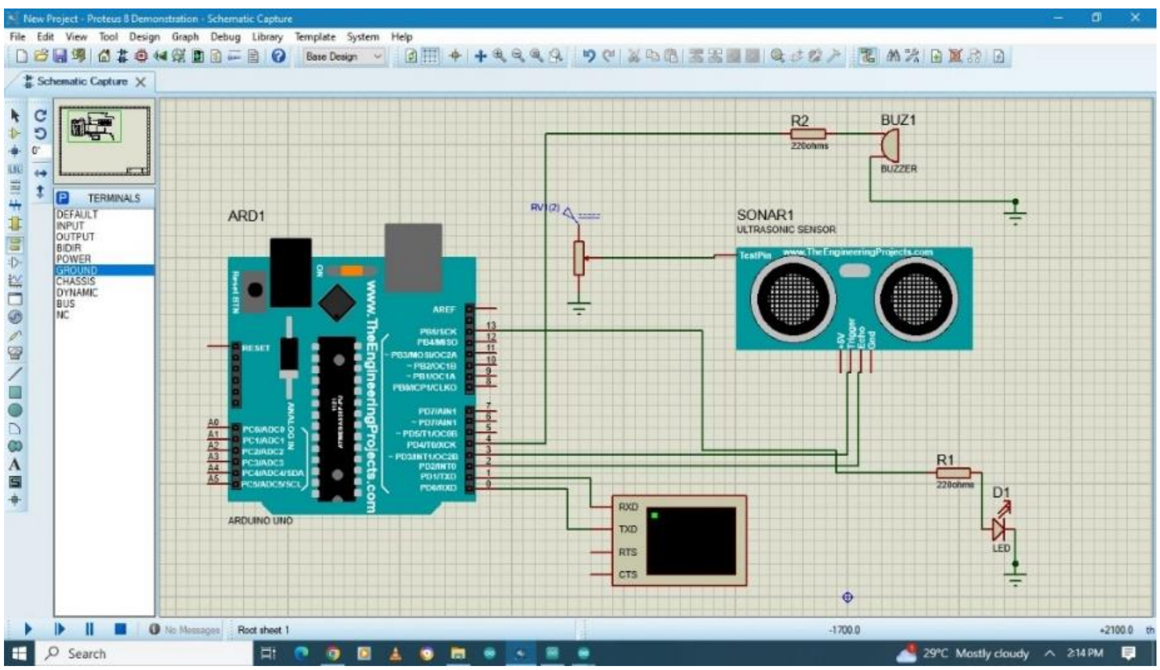

Figure 3. 13 Circuit Diagram

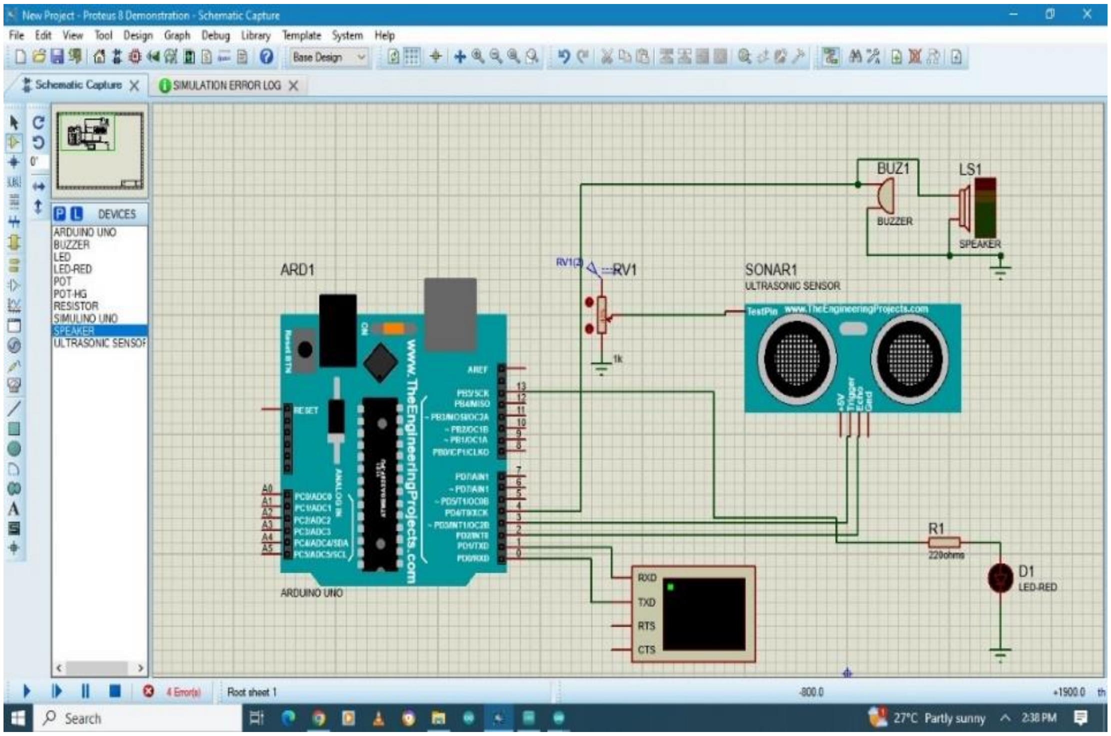

Figure 3. 14 Simulation Diagram

CHAPTER FOUR – RESULTS AND DISCUSSIONS

Introduction

This chapter shows the performance, results and the discussion of the project and also details the system used in arriving at our results

4.1. Result Analysis

Presented below is the integrated system of the project.

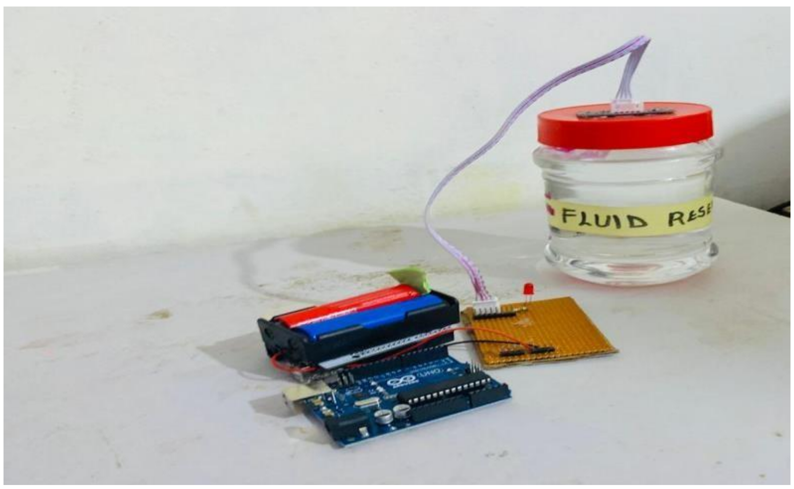

Figure 4. 1 Results Analysis of the System

4.2. Results Experiment

Following the assembly of all components and modules on the prototype board, it becomes crucial to conduct a rigorous testing not only on the individual circuit components but the overall integrated system as well. This testing is essential to validate the proper functioning of the system ensuring that both the hardware and software components as well as their interfacing perform optimally.

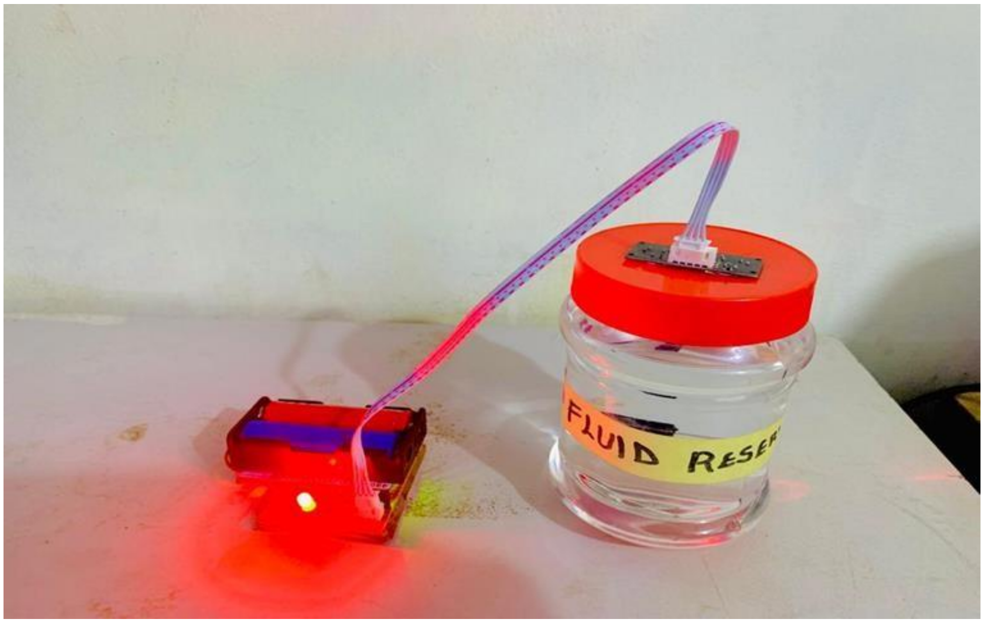

Figure 4. 2 Testing or Experimenting the Circuit

4.3. Results and Discussion

The project was focused on the design and installation of an automatic brake failure indication system with a primary objective of enhancing vehicle safety through the early detection of brake issues. As part of this project, by studying various journals, review papers and documents related to brake failure indication system, we were able to successfully designed an automatic prototype of brake failure indication system using an ultrasonic sensor, and a microcontroller (Arduino) with LED to implement the continuous monitoring of the brake fluid level which yielded a promising result. The results of this project are summarized below:

Successful Development: the automatic brake failure indication system was successfully designed and installed in the test system. The hardware and software components functioned as intended, providing the foundation for accurate brake system failure detection.

Reliable Brake Failure Detection: during testing and simulation, the system demonstrated consistently its ability to detect brake system issue. It effectively identified the brake fluid level when it was below the minimum point.

Safety Enhancement: The automatic brake failure indication system has the proven capability of significantly enhancing road safety.

Reduce accident risk: the system has the potential to reduce risk of accidents caused by brake failures. Timely warnings and indications can prevent catastrophic consequences on the road.

In conclusion, the automatic brake failure indication system has shown a great promise in enhancing vehicle safety by promptly detecting brake issues such as fluid leakage and this help in reducing the risk of road accidents and saving lives, also a successful design and installation of automatic brake failure indication mark a significant advancement in the automotive safety. The project results demonstrate the potential for substantial improvement in road safety and vehicle maintenance. The systems alert nature is a paradigm-shifter. Brake can lead to catastrophic accidents and any delay in detecting them can result in life- threatening. Also, with early detection of brake issue, maintenance could be scheduled proactively. This helped reduce the downtime of vehicles as brake problems could be addressed before they escalate into more dangerous and costly issues. The, ongoing research and development in this field can lead to further improvements, such as predictive maintenance features that predate brake issues before they become critical and as technology advances it may become a standard feature in vehicles, contributing to a safer and more secure driving experience.

CHAPTER FIVE – CONCLUSION AND RECOMMENDATIONS

5.0 Conclusion

Through the analysis of the result of design and installation of an automatic brake failure indicator presented in the chapter four. This chapter brings a conclusion to the whole research on the design and installation of an automatic brake failure indicator. This chapter also explains the limitations on the research and the recommendations for improvement.

The objective and aim of the project were designing and installation of an automatic brake failure indicator and after successful design and experimentation, the result of the automatic brake failure indication system has shown a great promise in enhancing vehicle safety by promptly detecting brake issues such as brake fluid leakage and this help in reducing the risk of road accidents and saving lives, also a successful design and installation of the system mark a significant advancement in the automotive safety.

The project results demonstrate the potential for substantial improvement in road safety and vehicle maintenance. brake failure can lead to catastrophic accidents and any delay in detecting them can result in life- threatening, therefore, the systems alert nature is a paradigm-shifter. Also, with early detection of brake issue, maintenance could be scheduled proactively. This helped reduce the downtime of vehicles as brake problems could be addressed before they escalate into more dangerous and costly issues. The ongoing research and development in this field can lead to further improvements, such as predictive maintenance features that predate brake issues before they become critical and as technology advances it may become a standard feature in vehicles, contributing to a safer and more secure driving experience.

5.1. Recommendations

Despite all these improvements made, there is more room for improvement. Therefore, it was recommended that in the future the project should be continued by the subsequent student batches in order for deeper research to be conducted to expand our understanding of the subject matter and to explore potential innovations and solutions. This continuity not only allow us to build upon the existing foundation but also offers an opportunity for students to apply the knowledge and skills gained from previous work. Furthermore, an ongoing project can foster the sense of institutional memory, enabling future generation of student to benefit from the insights and experience from their predecessors. This collaborative and cumulative approach is essential for making sustained progress and achieving meaningful advancement in the field.

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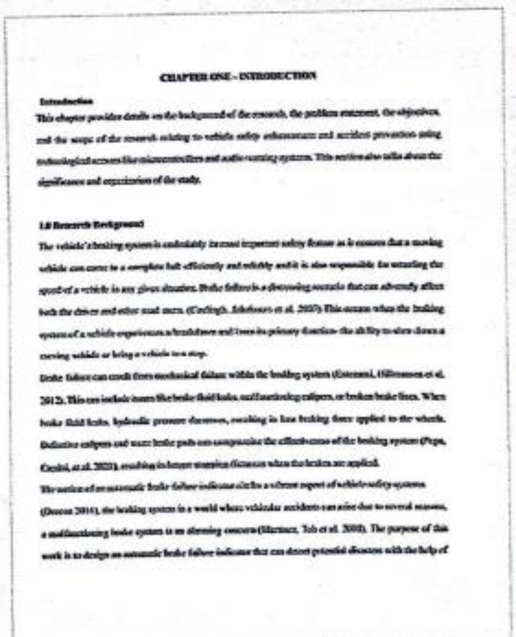
CHAPTER ONE - INTRODUCTION

Introduction

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