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AUTOMATIC VEHICLE BREAKING SYSTEM

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ABSTRACT

The Automatic Vehicle Braking System (AVBS) Project is a safety-focused innovation designed to enhance road safety and mitigate the risks of collisions on today's busy roadways. This project involves the development of a comprehensive AVBS that employs a combination of advanced sensors, a control algorithm, and braking actuation mechanisms to detect potential obstacles and automatically apply the brakes when necessary. The primary goal of the AVBS is to reduce the severity of accidents and improve passenger safety.

Key components of this project include a selection of sensors, such as ultrasonic sensors, cameras, lidar, or radar, which provide real-time data on the vehicle's environment, including road conditions, nearby obstacles, and the vehicle's own speed. A microcontroller or computer processes this sensor data and employs a sophisticated control algorithm to make decisions about when to engage the braking system. The system takes into account factors such as distance to obstacles, relative speeds, and driver inputs to determine the optimal braking strategy.

This project also emphasizes extensive testing and calibration to ensure the AVBS operates effectively and reliably in various driving scenarios, including different speeds and environmental conditions. Safety measures are incorporated to allow for manual overrides, emergency braking, and fail-safe mechanisms in case of system malfunctions.

Keywords: AVBS, Sensors, Braking, Safety, Etc.

I. INTRODUCTION

The Automatic Vehicle Braking System (AVBS) project represents a ground breaking initiative in enhancing road safety. With the ever-increasing volume of vehicles on our roadways, the AVBS addresses the pressing need for collision prevention through an amalgamation of state-of-the-art sensors, intelligent control algorithms, and precise braking mechanisms.

At its core, the AVBS project utilizes a network of sensors to continually monitor a vehicle's surroundings, detecting potential obstacles and promptly engaging the brakes when necessary. This automated system serves not only as a protective shield during critical situations but also as a reliable assistant to drivers in making safer decisions. The primary objective is to improve road safety for all, offering a promising solution to mitigate the risks of accidents in today's complex driving environments.

II. METHODOLOGY

The proposed framework displays remarkable adaptability, making it particularly suitable for deployment in densely populated areas. Its strength lies in its capacity for swift adaptation with minimal hardware modifications, such as the ability to adjust speed limits and control methods using software from the base station within a short time frame. The system relies on Arduino technology to gather speed-related data and transmit signals for operating the pneumatic brake, ensuring efficient deceleration at an appropriate distance. This study represents a significant stride in advancing brake technology.

2.1 Experimental Setup: The entire setup is arranged on a robust iron frame structure, with an air cylinder and control valve positioned at one end and a wheel mounted at the other. The wheel is placed on an axle with bearings and is driven by a motor via a belt drive with pulleys set in a velocity ratio of 1:7. A pneumatic brake is connected to the air cylinder through a slave cylinder, with a solenoid valve controlled by an Arduino board. During operation, the cylinder maintains a pressure of 30 psi, allowing air to flow from the air cylinder to the slave cylinder. A 330mm diameter wheel is powered by a motor through a belt drive. The pneumatic brake system, controlled by the Arduino board, is activated when an obstacle is detected by the ultrasonic sensor.

This releases high-pressure air onto the disc brake, effectively reducing wheel acceleration until it comes to a halt. A proximity sensor is employed in conjunction with a digital counting device to keep track of the wheel's rotations.

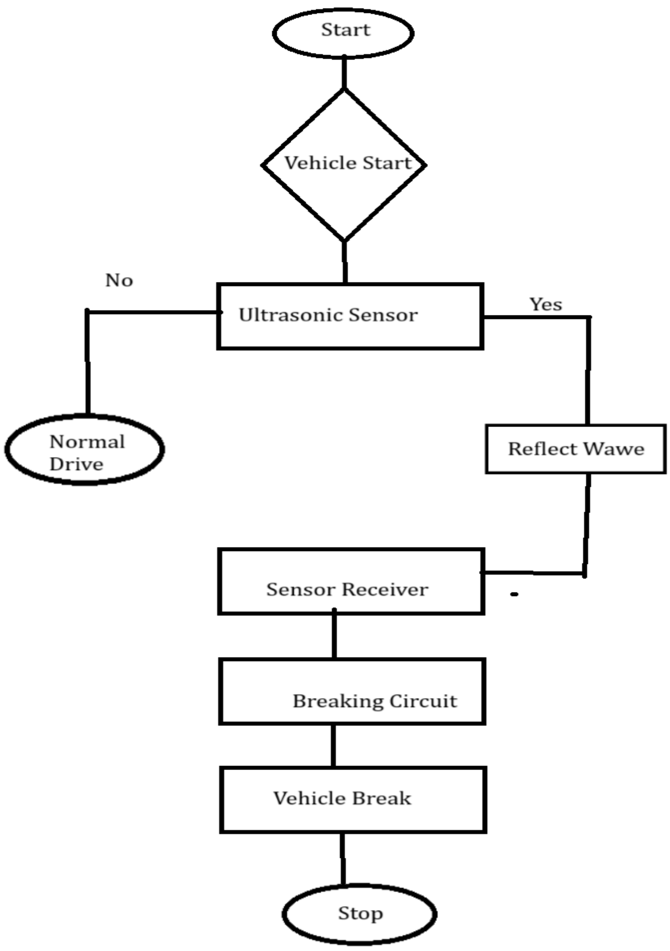

Figure 1: Flowchart

2.2 Performance of Arduino Board System: The Arduino system is based on the HC-SR04 model platform, featuring user-friendly hardware and software components. It comprises a circuit board, or microcontroller, and the Arduino IDE (Integrated Development Environment), a ready-made software for code writing and uploading to the physical board. A microcontroller, a compact computer on a single integrated circuit, combines a processor core, memory, and programmable input/output peripherals. Arduino boards can interpret signals from various sensors, analog or digital, and convert them into a range of outputs, from activating motors to controlling LEDs and even connecting to cloud-based services. Additionally, the Arduino IDE simplifies programming by using a streamlined version of C++. Notably, Arduino eliminates the need for an external programmer, as code can be uploaded using a simple USB cable, making it highly accessible for programming enthusiasts. Finally, Arduino's standardized form factor simplifies the microcontroller's functions, enhancing its usability and versatility.

III. MODELING AND ANALYSIS

The Automatic Vehicle Braking System (AVBS), also known as an Autonomous Emergency Braking (AEB) system, is designed to enhance road safety by automatically applying the vehicle's brakes when it detects a potential collision. Here's how the typical AVBS works:

1. **Sensor Technology:** AVBS relies on advanced sensors, such as radar, lidar, cameras, ultrasonic sensors, or a combination of these, to continuously monitor the vehicle's surroundings. These sensors capture data regarding the position, speed, and trajectory of objects, pedestrians, or other vehicles in the vicinity.

2. Data Processing: The sensor data is sent to a central processing unit (CPU) or microcontroller within the vehicle's control system. This CPU processes the data in real-time, analyzing the information to identify potential collision risks.

3. Obstacle Detection: The AVBS's software algorithms assess the sensor data to determine whether there's an imminent risk of a collision. This includes evaluating factors such as the vehicle's speed, the distance to the obstacle, and the rate of closure.

4. Collision Prediction: The system calculates the likelihood of a collision and the time available for the driver to react. If it predicts that a collision is imminent and there isn't enough time for the driver to brake safely, the AVBS initiates the braking process.

5. Brake Activation: The AVBS communicates with the vehicle's braking system to initiate brake application. It can either assist the driver's braking input or, in more advanced systems, take full control of the braking mechanism.

6. Progressive Braking: To prevent abrupt stops and reduce the risk of rear-end collisions with vehicles following behind, the AVBS typically engages the brakes progressively. This means that it gradually reduces the vehicle's speed to avoid a sudden halt.

7. Alerts: Simultaneously, the system may issue visual or auditory warnings to alert the driver about the impending collision. These warnings are crucial if the AVBS is assisting the driver rather than taking complete control.

8. Driver Override: Many AVBS systems include a driver override feature that allows the driver to regain control of the vehicle. The driver can still independently apply the brakes if they become aware of the situation and wish to take control.

9. Data Logging: Some AVBS systems log data related to the incident, including sensor readings, vehicle speed, brake activation, and other relevant information. This data can be useful for analysis and accident reconstruction.

10.Resume Normal Driving: Once the collision threat is mitigated, and the vehicle is at a safe distance from the obstacle, the AVBS gradually releases the brakes, allowing the driver to resume normal driving.

IV. COMPONENTS REQUIREMENTS

1. Ultrasonic Sensor (transmitter and receiver): Ultrasonic sensors use sound waves to detect objects or obstacles in the vehicle's path. They emit high-frequency sound waves, and the receiver measures the time it takes for the sound waves to bounce back. This data is used to calculate distances to objects.

Figure 2: Ultrasonic Sensor

2. Microprocessor: The microprocessor, often referred to as a central processing unit (CPU), is the brain of the system. It receives data from the sensors, processes it, and makes decisions based on predefined algorithms. The microprocessor controls the braking system and other components of the AVBS.

Figure 3: Arduino

3. Electric Motor (DC gear motor): In an AVBS, an electric motor can be used to control various aspects of the vehicle, such as actuating the braking system or controlling the throttle to reduce speed.

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Figure 4: DC Motor

4. Servomotor: Servomotors are often used for precise control of components. In the context of an AVBS, a servomotor may be employed for tasks like adjusting the vehicle's steering, contributing to collision avoidance.

Figure 5: Servo Motor

5. Braking System: The braking system is a critical component of the AVBS. When a potential collision is detected, the system engages the brakes to slow down or stop the vehicle. This may involve activating the vehicle's existing brake system or a specialized pneumatic or hydraulic brake.

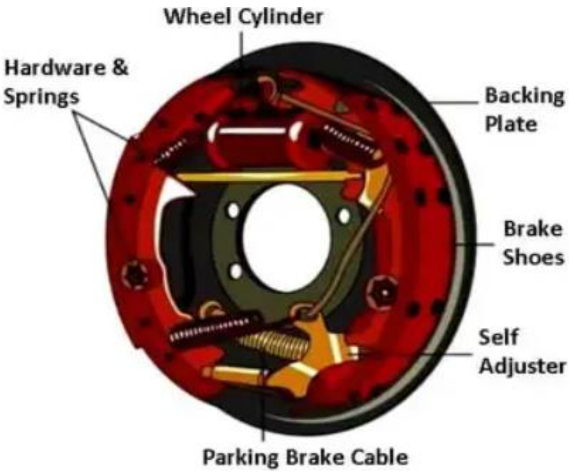

Figure 6: Breaking System

V. RESULTS AND DISCUSSION

1. Obstacle Detection: The central aim of this system is to ensure the safety of the driver and the vehicle by detecting obstacles in the vehicle's path. This is accomplished by employing ultrasonic sensors that continuously scan the surroundings of the vehicle. These sensors emit signals that bounce off objects and return data about the vehicle's proximity to potential obstructions.

2. Vehicle Speed Control: Within this configuration, a microcontroller assumes control over regulating the vehicle's velocity. It interprets the inputs from various sensors, including the ultrasonic sensors and infrared sensors, to determine the vehicle's speed based on the observed distances from nearby obstacles.

3. Ultrasonic Obstacle Detection Circuit: Ultrasonic sensors operate on the principle of sending high-frequency sound waves into the environment. This study leverages an ultrasonic piezo transmitter coupled with a receptor, offering efficiency, ease of installation, and cost-effectiveness. Initially, a 20 kHz pulse, derived from a PIC pulse width (PWM) output, is dispatched. To substantially expand the sensor's range, a specialized circuit enhances the transmitted pulse to 200 kHz, boosting the sensor's effective range to approximately 75 feet.

4. Automatic Braking System Activation: The moment an obstacle is detected in the vehicle's path, the system promptly communicates the measured distance between the vehicle. If the system identifies a minimal separation between the vehicle and an obstacle, it initiates a reduction in the vehicle's speed. Furthermore, in scenarios where there is very little room between two vehicles or between a vehicle and an obstruction, the IR sensor recognizes this predicament and activates the automatic braking system.

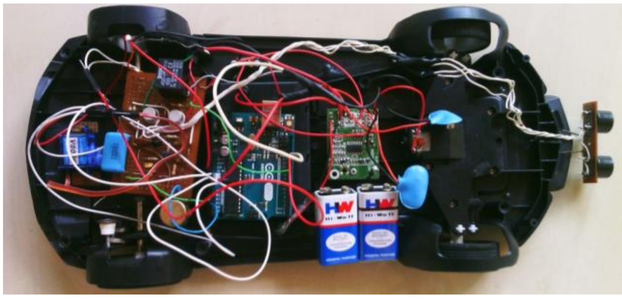

Figure 7: Project Picture

VI. CONCLUSION

A series of experiments were carried out to determine the stopping distance of the vehicle at various speeds. The results showed that the stopping distance decreases as the vehicle speed decreases and vice versa. This indicates that the vehicle decelerates gradually, a desirable characteristic. Notably, the curve exhibits a significant change in slope after a speed of 30 km/hr, with the vehicle coming to a halt within a 5-meter distance. Higher speeds were not tested, as it was assumed that drivers in low or poor light conditions would exercise caution regarding their speed. This system is particularly valuable for situations where a driver is fatigued or drowsy during a long journey, potentially reducing accidents resulting from such conditions.

In summary, the system exhibited a response failure if the distance between the vehicle and an obstacle was less than 0.5 meters, even at a speed of 10 km/hr. However, when the driver was inattentive and the object's distance ranged from 0.5 to 25 meters, with the vehicle speed between 10 km/hr and 50 km/hr, collisions could be avoided. It's essential to note that the methodologies and conclusions presented here are preliminary and require further in-depth analysis. Additionally, it's worth considering the scenario where sensors may fail to detect obstacles while the vehicle is making a turn, which could be addressed by installing sensors on the vehicle's wheels capable of measuring wheel rotation. Presently, this system is well-suited for automatic transmission vehicles, but with some adjustments, it could be adapted for use in various vehicle types.

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