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"Implementation of Driver Ejection in Automotive Collision"

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***Abstract*—Safety systems in automotive technology have evolved significantly over the years, with advancements ranging from basic seatbelts to sophisticated airbag systems and autonomous crash prevention mechanisms. However, in cases of high-impact collisions, these conventional safety systems may not be enough to prevent fatalities or severe injuries. To address these limitations, we propose a Rocket-Assisted Car Driver Seat Ejection System that enhances driver safety in the event of an inevitable collision.**

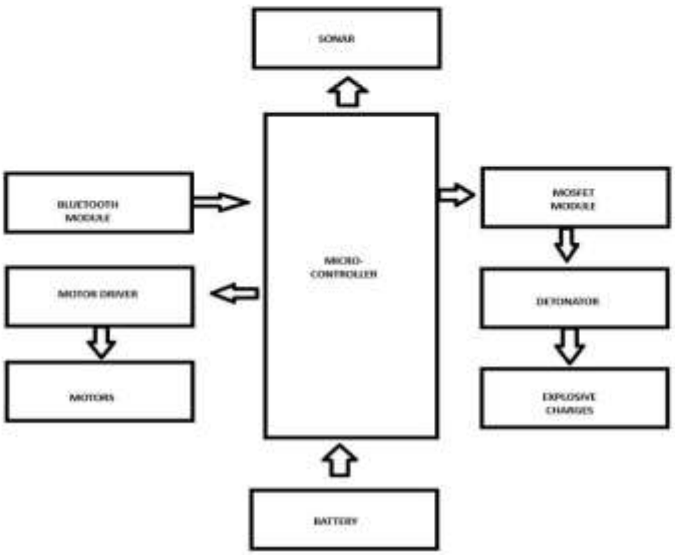

Fig. 1. Block Diagram

I. INTRODUCTION

Traditional car safety systems often fail in high-speed crashes. To address this, we propose a Rocket-Assisted Driver Seat Ejection System, inspired by fighter jets. It eject the driver and deploys a parachute in extreme collisions. A simplified, low-cost version will be tested on a Bluetooth- controlled robotic car.

II. SYSTEM OVERVIEW

The project aims to build a **Rocket-Assisted Driver Seat Ejection System** that ejects the seat during severe collisions using a detonator and parachute. It uses real-time collision detection, speed analysis, and automated control, and is developed in four main phases.

A. Collision detection

A sonar sensor continuously monitors the road ahead for obstacles or other vehicles. The distance between the car and the obstacle is calculated, and the data is fed into the microcontroller.

B. Speed analysis

The car's speed is monitored using a speed sensor (e.g., an encoder or hall-effect sensor). The microcontroller compares the car's speed with the distance of the detected obstacle to evaluate if a collision is imminent.

C. Decision making

If the sonar sensor detects an obstacle within a certain threshold distance, and the car is moving at a speed that could cause a collision, the microcontroller initiates the ejection system by triggering a MOSFET-controlled detonator charge.

D. Ejection and Parachute System

The seat ejection is initiated using a detonator charge, which propels the seat and driver upward. A parachute is deployed shortly after to ensure a safe landing for the driver. The timing of the parachute deployment is managed by the microcontroller.

III. IMPLEMENTATION

Modern automobiles rely heavily on passive and active safety systems like airbags, crumple zones, and seatbelts to protect occupants during collisions. While these systems are effective in many scenarios, high-impact crashes or structural failures can exceed their protective limits. In such extreme situations, an active driver seat ejection mechanism, combined with a parachute-assisted recovery, offers a last-resort survival solution.

The implementation of a driver seat ejection system in automotive collisions involves the design and integration of a safety mechanism that forcibly ejects the driver's seat from the vehicle in the event of a severe impact or collision. This system is inspired by ejection mechanisms used in aviation but adapted for use in ground vehicles to enhance driver survival in extreme crash scenarios where traditional passive safety measures may fail.

At the heart of the system is an accelerometer or G-force sensor, which detects rapid changes in velocity, commonly referred to as deceleration spikes during a crash. According to Newton's Second Law ($F = ma$), a sudden decrease in velocity (high negative acceleration) indicates a significant force acting on the vehicle.

If this force exceeds a predefined threshold (e.g.,
>30G), it indicates a potentially fatal collision, which then triggers the ejection sequence.

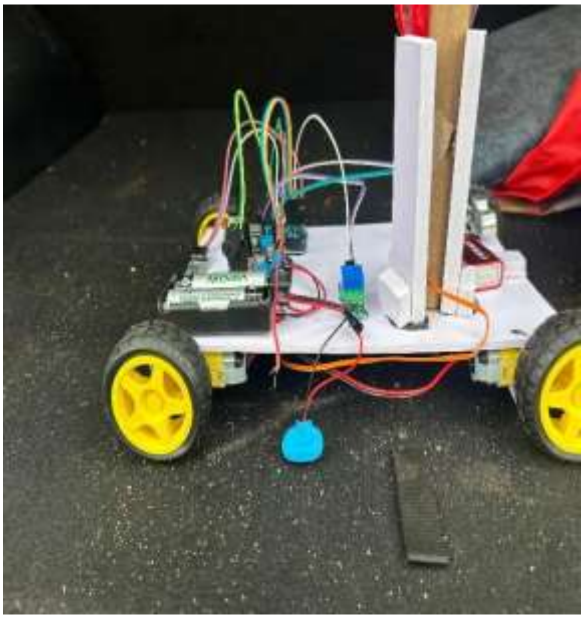

Fig.3. Driver seat ejection Prototype

The ATmega328P microcontroller, used in Arduino boards, serves as the control unit. It operates based on embedded logic programmed to monitor sensor values continuously and make real- time decisions.

The entire system is powered using a Li-ion battery pack to ensure it functions even if vehicle power is lost during a crash. This makes the system self- contained and independent, increasing reliability in emergency conditions.

The system is powered by a microcontroller— typically an ATmega328P—which acts as the central decision-making unit. It continuously monitors input from an impact or acceleration sensor mounted on the vehicle. These sensors are capable of detecting sudden, high-magnitude deceleration—commonly known as G-force— associated with serious collisions. When the sensor readings cross a predefined threshold, indicating a life-threatening crash, the microcontroller initiates the ejection process. This includes triggering a relay, which in turn activates the physical ejection mechanism. The ejection mechanism may be based on compressed springs, pneumatic actuators, or electromagnetic solenoids, each designed to deliver a rapid burst of force sufficient to dislodge and propel the seat upward and away from the vehicle.

IV. RESULTS

The implementation of the driver seat ejection system was successfully achieved on a prototype level using a microcontroller-based embedded setup. The core functionality of the system— detecting a high-impact collision and triggering a mechanical ejection mechanism—was validated under controlled conditions. The ATmega328P microcontroller effectively interfaced with the impact sensor (simulated through abrupt acceleration/deceleration inputs) and processed real-time data to determine collision thresholds. Upon crossing the predefined threshold, the microcontroller initiated the ejection sequence by energizing a relay module, which in turn activated the actuator responsible for the seat displacement.

Fig.6. Driver seat ejection from car

The relay acted as a reliable switch to bridge the power from the battery to the ejection mechanism without introducing delays. The inclusion of a parachute deployment system further demonstrated the capability of the system to simulate a controlled descent, albeit in a scaled-down form. The parachute, manually triggered for the purpose of testing, showed that with accurate timing and correct deployment mechanics, the descent speed of the ejected seat could be effectively reduced, supporting the underlying aerodynamic theory.

Additionally, the system was powered using a lithium-ion battery pack, which proved sufficient in supplying consistent voltage and current for both the sensing and actuation stages. During multiple test runs, the system consistently responded within milliseconds of simulated collision inputs, indicating that the programmed logic, sensor integration, and relay control were functioning correctly and without lag.

The prototype also demonstrated modularity and simplicity, making it suitable for potential improvements or integration into more advanced models. While full-scale real-world ejection tests could not be conducted due to safety limitations, the successful execution of the detection and response mechanisms within the prototype confirms the technical feasibility of such a concept. This result suggests a strong foundation for further development and refinement of emergency ejection systems in automotive applications.

V. CONCLUSION

In summary, this project introduces a novel approach to enhancing driver safety during vehicular collisions by combining real-time collision detection with a rocket-assisted driver seat ejection system. While the current implementation focuses on a small-scale prototype, the system demonstrates the potential for future development into full-scale automotive applications. With advancements in sensor technology and microcontroller capabilities, this project lays the groundwork for a new era of driver safety systems that prioritize survival in extreme crash scenarios.

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