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Security Layer Enhancement System in Passenger Vehicles Using Can Protocol

[1] Ruban Thomas D.,[2] Dinesh D.,[3] Parthiban S.,[4] Praneeth Kumar S. P., [5]Prabhu V.
[1] Assistant Professor, ECE, Vel Tech Multi Tech Dr. Rangarajan Dr. Sakunthala Engineering College
[2,3,4] UG Scholar, ECE, Vel Tech Multi Tech Dr. Rangarajan Dr. Sakunthala Engineering College
[5]Professor, ECE, Vel Tech Multi Tech Dr. Rangarajan Dr. Sakunthala Engineering College

Abstract:- Cars with CAN bus-like protocols have the potential to be security-based solutions. Cars don't have any kind of fault detection system. When their cars have small problems, owners of the vehicles frequently call mechanics; nevertheless, if the mechanic is dishonest, he could inflate the problem's severity in order to charge more. Nowadays, driving is safer, simpler, and demands less of the driver. Vehicle safety has become a primary concern for modern civilization. Drivers neglect their cars far too frequently. People simply forget occasionally to get their cars serviced when they ought to. An essential component of car upkeep is vehicle servicing. It is obvious that drunk drivers cause the great majority of accidents. Consequently, there isn't a trustworthy way to prevent this.

***Keywords**: Indian car CAN bus protocol, defect detection, dishonest mechanics, vehicle safety, driver negligence, intoxicated driving.*

1. Introduction

In the current era of automotive innovation, producers, authorities, and consumers all have the same top priority, creating safer and more dependable automobiles. Notwithstanding notable progressions in automobile technology, the automotive sector continues to encounter obstacles in guaranteeing thorough car safety and upkeep [1]. Robust systems that can proactively address these challenges are desperately needed, from defect detection to protecting drivers from unanticipated events.In this concept, a security-based system that makes use of the car's Controller Area Network (CAN) bus protocols is proposed as a novel approach to vehicle safety and maintenance [2]. This technology seeks to revolutionize roadside vehicle protection and maintenance by combining advanced monitoring, defect detection, and driver behaviour analysis capabilities [3].This proposal's constant monitoring of fault characteristics and driver behaviour is its first crucial component. In the past, reactive maintenance has been the mainstay of vehicle repair, with problems being addressed only after they have become apparent [4]. However, this suggested approach enables cars to foresee possible issues before they become safety threats by utilizing cutting-edge sensors and clever algorithms. Cars that have this technology installed can proactively detect and reduce dangers by continuously evaluating fault data and driver behaviour patterns, which improves road safety overall [5].This suggested system's incorporation of CAN Network Management (CNM) logic—which is especially designed to handle communication layer issues—is essential to its efficiency [6]. Modern carcommunication systems are based on the CAN bus, which makes information sharing between different electronic control units (ECUs) in the car easier [7][8]. On the other hand, weaknesses in the communication layer may jeopardize the overall vehicle system's dependability and safety [9]. This system's use of CNM logic reduces the possibility of malfunctions or manipulation by dishonest actors by promptly identifying and fixing communication faults and guaranteeing the reliable transmission and reception of vital information [10][11].In addition, the suggestion highlights how crucial it is to give owners and drivers user-friendly interfaces so they can recognize and resolve issues as they arise [12]. Liquid Crystal Display (LCD) interface integration enables users to quickly and easily examine diagnostic data and gain actionable insights to address problems [13]. This openness encourages trust and confidence in the dependability of the system in addition to enabling car owners to perform preventative maintenance actions.The suggested system's integration of dynamic-CNM (D-CNM) logic into the slave and master ECUs is another important component

[14]. Conventional fault tolerance techniques sometimes rely on failover systems or redundant components, which can be expensive and time-consuming to set up. As an alternative, D-CNM logic dynamically reallocates control functions in reaction to ECU faults, providing a more flexible and effective fault management method [15]. This adaptive capacity improves safety and dependability by ensuring that the vehicle will continue to operate even in the event that a component malfunction [16].Moreover, the focus on error correction and real-time communication highlights how adaptable the system is to changing threats and difficulties [17]. Through the facilitation of rapid decision-making and seamless interaction between vehicle components, this system can efficiently eliminate risks and maintain optimal performance under a variety of operating situations. The suggested system provides a complete solution to improve vehicle safety and maintenance, whether it is identifying driver anxiety or anticipatorily correcting mechanical issues [18].In conclusion, a major advancement in the development of safer and more dependable automobiles has been made with the deployment of a security-based system that makes use of CAN bus protocols. This technology improves proactive safety measures and expedites maintenance procedures by combining advanced monitoring, problem detection, and driver behaviour analysis capabilities [19]. This ultimately ensures a safer and more secure driving experience for everyone. Investments in cutting-edge technology like this suggested system will be vital in determining the direction of autonomous mobility as we move forward and impact the future of the automotive industry for years to come [20].

2. Literature survey

The security of their cars is a concern for the general public these days. It is simple to replace an existing car's alarm system because the necessary parts are easily obtained. Even though being safe is everyone's top goal when traveling.

Dhulipudi et al.[7] proposed a framework for a smart and secure vehicle intelligent life monitoring system addresses the growing importance of cybersecurity and data privacy in modern vehicles. By integrating intelligent monitoring systems with robust security protocols, they ensure that vehicles remain protected from cyber threats and unauthorized access. Additionally, their emphasis on real-time monitoring enables proactive maintenance and fault detection, contributing to the overall reliability and safety of vehicles. This research represents a crucial step towards building trust and confidence in the safety and security of connected vehicles, laying the foundation for the widespread adoption of intelligent transportation systems in the future.

Shadrin et al. [8] proposed a highly automated vehicle safety monitoring system using virtual testing procedures sheds light on innovative approaches to ensuring the safety and reliability of autonomous vehicles. By leveraging virtual testing environments, they enable comprehensive evaluation and validation of vehicle safety systems in a controlled and repeatable manner. This approach allows for the identification of potential safety issues and vulnerabilities early in the development process, ultimately leading to safer and more robust autonomous vehicles. As the automotive industry continues to advance towards autonomy, methodologies like those proposed by Shadrin and Makarova will be instrumental in ensuring that autonomous vehicles meet the highest standards of safety and reliability.

Philip et al. [11] proposed a system that focus on vehicle detection and collision avoidance systems highlights the importance of advanced safety technologies in reducing accidents and improving road safety. By developing methodologies for detecting and avoiding collisions, they contribute to the development of safer and more reliable vehicles. Their research has implications for vehicle manufacturers, regulatory agencies, and consumers, where the adoption of collision avoidance systems can lead to significant improvements in safety and peace of mind. As road traffic continues to increase worldwide, innovative technologies like those proposed by Philip et al. will play a crucial role in mitigating the risk of accidents and saving lives on the road.

Meng et al. [12] proposed a vehicle testing based on digital twins theory for autonomous vehicles demonstrates the potential of virtual testing procedures in evaluating the safety and performance of autonomous driving systems. By creating digital replicas of vehicles and their environments, they enable comprehensive testing and validation in simulated scenarios. This approach allows for the identification of potential safety issues and vulnerabilities early in the development process, ultimately leading to safer and more reliable autonomous vehicles. As the automotive industry continues to advance towards autonomy, methodologies like those proposed by Meng et al. will be instrumental in ensuring that autonomous vehicles meet the highest standards of safety and reliability.

Widner et al. [14] proposed a two-wheel vehicle model using genetic algorithms demonstrates the potential of computational techniques in optimizing vehicle dynamics and performance. By leveraging genetic algorithms for parameter estimation, they enable the calibration and validation of vehicle models with improved accuracy and efficiency. Their research addresses a fundamental aspect of vehicle engineering, ensuring that mathematical models accurately represent real-world dynamics. This methodology not only enhances the fidelity of vehicle simulations but also contributes to the development of safer and more reliable vehicles. As computational techniques continue to advance, methodologies like those proposed by Widner et al. will play a crucial role in accelerating the vehicle development process and improving overall vehicle performance and safety.

Luo et al. [16] proposed a method for fault-tolerant control of an eight in-wheel-driving autonomous vehicle demonstrates the importance of robust control strategies in ensuring vehicle safety and reliability. By developing fault-tolerant control algorithms, they enable vehicles to continue operating safely even in the presence of component failures. Their research has implications for various industries, including automotive, aerospace, and robotics, where safety-critical systems are essential for mission success. As autonomous vehicles become increasingly prevalent, robust fault-tolerant control strategies will be critical for ensuring the safety and reliability of these vehicles in real-world applications.

Bian et al. [17] proposed an autonomous underwater vehicle manipulator system (UVMS) represents a significant advancement in underwater robotics technology. By designing a system capable of autonomously capturing underwater targets, they enable a wide range of applications in marine exploration, research, and industrial operations. Their research contributes to the growing field of underwater robotics, where autonomous systems play a crucial role in overcoming the challenges of underwater environments. As interest in marine exploration and exploitation continues to grow, innovations like those presented by Bian et al. will be essential for unlocking the potential of the world's oceans and advancing scientific understanding.

3. Proposed methodology

Installing a CAN bus-like protocol in Indian cars is the recommended method to ensure vehicle safety and trouble detection. With the use of D-CNM logic for fault isolation and CNM logic for fault diagnosis, this system allows for effective error management and quick communication between ECUs to prevent loss of vehicle control. The hardware consists of an LCD display, an Arduino Uno, a CAN module, a temperature sensor (LM35), and a GSR sensor.

1. **Fault Detection and Maintenance Parameters:**To find problems with the CAN communication layer, use CNM logic. Use sensors and diagnostic instruments to monitor the condition of the engine, transmission, brake system, and other parts of the vehicle. Develop algorithms that can sort through sensor data and identify issues or upkeep requirements. Display trouble information on an LCD interface that is easy for owners or drivers to understand.
2. **Driver Activity Monitoring:**Install sensors that monitor the movements of the driver, including steering patterns, speed, and rates of acceleration and deceleration. Develop algorithms that can recognize signs of nervousness or illness in drivers, like swerving, braking suddenly, or odd driving behaviours. Establish procedures for alerting drivers to suspect activities or for corrective action to be taken. This could entail initiating actions to control the vehicle or issuing notifications.
3. **Accident Prevention:**Using the details you have gathered regarding the driver's behavior and the state of the car, compile a list of potential crash scenarios. Install safety technologies that can be used to prevent accidents, such as collision avoidance systems, adaptive cruise control, and lane departure alarms. Integrate with existing safety elements, including airbag deployment systems, to increase overall accident prevention capabilities.
4. **Dual-CNM (D-CNM) Logic Implementation:**D-CNM logic must be programmed into the master and slave ECUs of the car. Create algorithms to monitor each ECU's health and functionality on a constant basis. Use

D-CNM to identify the problem and switch control to the unaffected ECU if one of the ECUs is impacted, whether internally or externally. Preserving engine power and preventing loss of control are facilitated by a smooth handoff.

5. **Real-Time Communication and Error Handling:**Enable real-time communication between ECUs by utilizing the fast CAN protocol. CAN network connectivity issues can be resolved by putting in place trustworthy error handling systems. Create mechanisms to ensure that control directives are distributed on schedule and that critical communications are given top priority.
6. **Temperature Monitoring and Management:**Install LM35 temperature sensors to obtain real-time engine temperature readings. Develop algorithms that can track engine temperature and recognize risky conditions like overheating. Two examples of safety precautions that can be implemented to prevent engines from overheating and malfunctioning include lowering power output or turning on cooling systems.
7. **Hardware Requirements:**Galvanic Skin Response (GSR) technology is used in the driver monitoring system. Microcontroller for data processing and control logic implementation that is built on the Arduino UNO platform. CAN communication with the MCP2515 module. using the LM35 sensor to monitor engine temperature. unit that consistently provides electricity to every area. An LCD display that is easy to use and provides information about system status and issues.

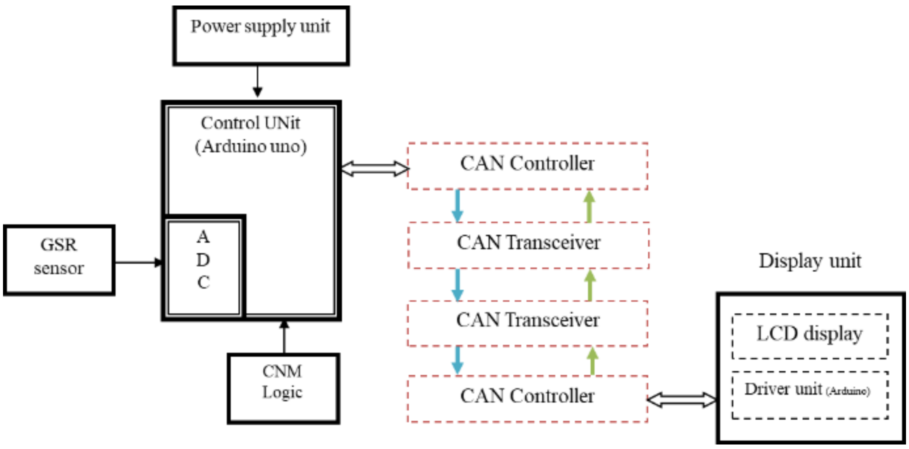

Fig. 1: Proposed Block Diagram - Phase 1

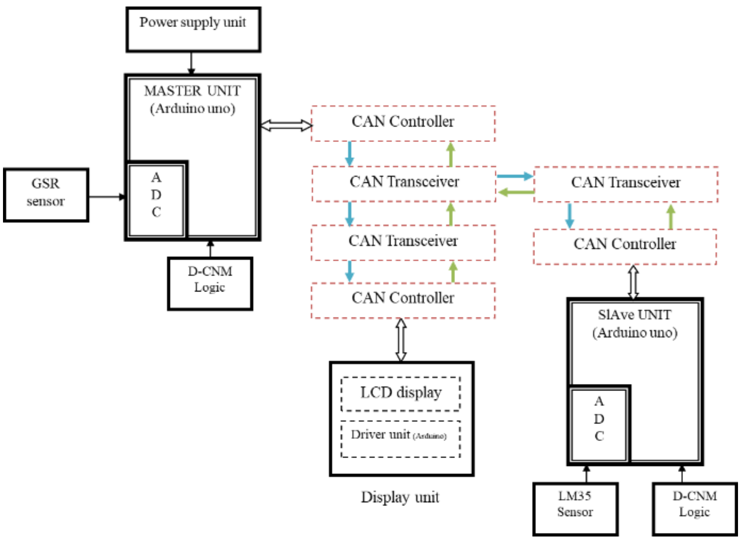

Fig. 2: Proposed Block Diagram – Phase 2

4. Result and analysis

The proposed method is a two-pronged approach to enhancing vehicle dependability and security. To identify issues with the vehicle's characteristics in the first stage, the system uses CNM logic, which is comparable to the CAN bus protocol. Its technology, which permits quick fault identification and presents diagnostic data on an LCD display that is easy to use, gives drivers and owners the ability to resolve issues quickly. In order to lower the risk of accidents, the system also includes activity monitoring for drivers to ensure they are neither ill nor nervous when operating a vehicle.

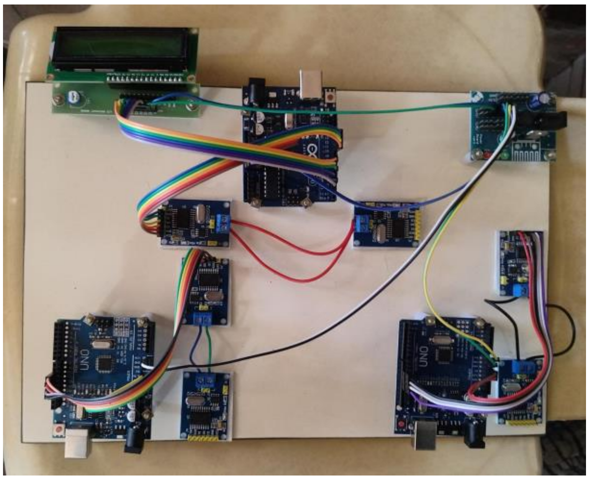

Fig 3: Hardware kit

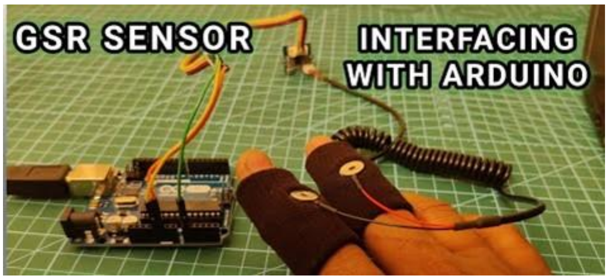

Fig 4: GSR Sensor Interfacing with Arduino

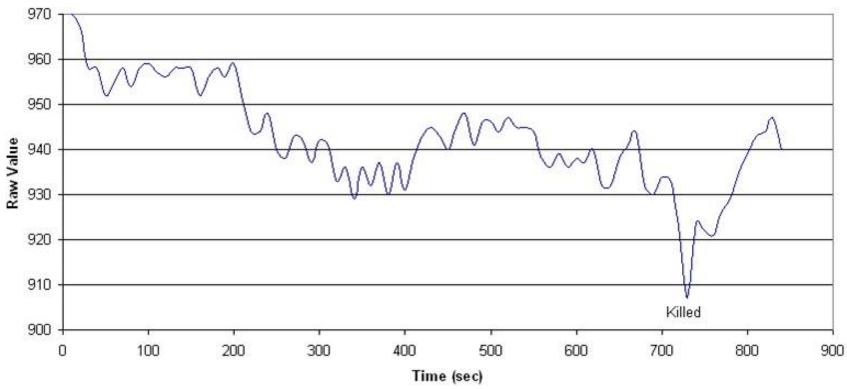

Fig 5: Signal Analysis

Phase 2 consists of integrating D-CNM logic into the slave and master ECUs to increase fault tolerance. The system analyses potential issues with the ECUs and then transfers control to the unaffected ECUs to prevent the vehicle from losing control. The system includes a component for sensing engine temperature using an LM35 temperature sensor in order to further ease real-time monitoring of engine health.

The proposed method offers a number of advantages. Firstly, it facilitates early problem detection, resulting in fewer traffic accidents and dangers. Second, the adoption of D-CNM logic ensures reliable error management and fast, real-time communication between ECUs, both of which enhance vehicle dependability. Furthermore, the system paves the way for future technological advancements that will raise the bar for vehicle upkeep and safety.

An MCP2515 CAN module, an LCD display, a power supply, an Arduino UNO CPU, a GSR sensor, and an LM35 temperature sensor are among the system's essential hardware components. Together, these components enable the suggested system to become a reality and address every issue pertaining to vehicle dependability and safety in India.

Finally, the method that has been proposed is a promising means of enhancing the reliability and security of automobiles in India. By employing advanced flaw detection techniques and real-time communication protocols to lower the risk of accidents, the system seeks to make driving safer for all users.

5. Conclusion

Finally, the proposed approach provides a comprehensive solution to the most critical issues regarding the dependability and safety of Indian automobiles. To lessen the possibility of accidents brought on by malfunctioning vehicles and driver-related problems like nervousness or illness, the system makes use of sophisticated defect detection techniques and real-time communication protocols. The system employs a two-pronged approach that first detects issues with the vehicle's characteristics before dynamically transferring control to unaffected components in order to prevent accidents and loss of control.

Furthermore, modern technology such as D-CNM logic and LM35 temperature sensors is employed to efficiently manage mistakes and monitor engine health, resulting in improved performance and extended vehicle life. The LCD screen gives drivers and car owners greater control over the safety of their vehicles by making it simple to identify and address issues swiftly.

Taking everything into account, the proposed approach is an excellent starting point for improving the dependability and security of India's transportation system. The major objective of the system is to reduce the frequency and severity of traffic accidents brought on by things like negligent vehicle maintenance and human mistake, therefore saving lives and encouraging safe driving behaviors. This system's scalability and compatibility with upcoming advancements in automotive technology make it a viable long-term solution to the issue of pedestrian and driver safety.

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