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SMART TORQUE MANAGEMENT SYSTEM WITH IOT - DRIVEN SAFETY INTEGRATION

PRIYANKA MANNE[1], S. VASAVI[2], T. AMRUTHA[3], V. RAJITHA[4]

ASSISTANT PROFESSOR[1], UG SCHOLAR [2,3&4]

DEPARTMENT OF ECE,MALLA REDDY ENGINEERIGNG COLLEGE FOR WOMEN (UGC-AUTONOMOUS),

MAISAMMGUDA, HYDERABAD, TELANGANA-500100

ABSTRACT— This paper presents an intelligent torque control system designed to enhance vehicle safety by adjusting torque output based on the type of passenger. The system is tailored to ensure the safety of children and the elderly, with torque limits set at 40 for these groups, while accommodating adults with a limit of 70. In emergency situations, the system operates without torque restrictions to allow for quick responses. Key components of the system include the ESP8266 microcontroller, LM 398N motor driver, four geared motors, Blink IoT module, a battery, and the TP 4056 charging module, all working together to deliver optimal performance. The system is equipped with three user-friendly buttons—Child, Adult, and Emergency—that allow users to easily select the appropriate torque setting. The research offers valuable contributions to vehicle safety by introducing a flexible and adaptable torque control mechanism, aimed at reducing the risks of accidents and improving overall road safety for passengers. By integrating IoT technology with intelligent torque control, this system has the potential to significantly advance the future of automotive safety. The system's ability to adjust to different passenger needs, while maintaining quick responsiveness in critical situations, demonstrates its importance in enhancing vehicle safety. The combination of the ESP8266 microcontroller, LM 398N motor driver, and other key components ensures a robust and reliable safety mechanism. Further development and testing could lead to broader applications of this system, potentially benefiting a wide range of vehicles and scenarios where passenger safety is paramount. Future improvements could include refining the torque adjustment algorithm for more precise control, as well as exploring additional features that contribute to further enhancing vehicle safety. Additionally, as IoT technology continues to evolve, there may be opportunities to integrate more advanced monitoring and control systems to ensure that vehicle safety mechanisms are both adaptive and responsive to real-time conditions.

Index Terms— Internet of Things (IOT), ESP8266 Module, Motor drivers, Arduino IDE.

I. INTRODUCTION

In response to the growing demand for enhanced vehicle safety, this paper introduces an innovative torque control system that adjusts torque output based on the demographic characteristics of passengers in the vehicle. The system prioritizes the safety of vulnerable groups, such as children and the elderly, by limiting torque to 40 for these individuals, while accommodating adults with a higher limit of 70. Additionally, the system operates without torque restrictions during emergencies, enabling swift and efficient responses in critical situations. The system's architecture is built around advanced components, including the ESP8266 microcontroller, LM 398N motor driver, four geared motors, Blink IoT module, a battery, and the TP 4056 charging module, which work together to ensure seamless and optimal performance. To improve usability, the system is equipped with a simple interface featuring three buttons: Child, Adult, and Emergency. These buttons allow users to easily select the desired torque setting, ensuring safety for all passenger groups and allowing for quick adjustments during urgent situations. This research marks a significant advancement in vehicle safety systems by introducing a flexible and adaptive torque control mechanism. The system's ability to adjust to the specific needs of different passenger groups could greatly reduce the risk of accidents and improve road safety overall. By integrating IoT technology with intelligent torque control, this system is well-positioned to meet current safety requirements while also offering a foundation for future advancements in automotive safety. The system’s combination of real-time data processing and automatic torque adjustments offers a promising solution for ensuring the protection of passengers across various demographics. Looking ahead, further research could focus on refining the torque adjustment algorithms to achieve even more precise control based on additional parameters such as vehicle speed, road conditions,

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and the specific needs of each passenger. Incorporating more sensors to monitor the real-time health and status of the passengers could enhance the system's ability to adapt to dynamic conditions. Additionally, exploring machine learning techniques to predict and adjust torque based on a passenger's behavior or posture could improve the system's responsiveness and effectiveness. Another avenue for development is expanding the system's integration with other vehicle safety mechanisms, such as adaptive braking or collision avoidance systems. A comprehensive, interconnected safety network within vehicles could create a more holistic approach to accident prevention. The implementation of such integrated systems could further elevate the safety standards for both individual vehicles and the transportation industry as a whole. The adoption of IoT technology plays a pivotal role in making this system scalable and adaptable to different vehicle models. With the continuous evolution of IoT networks, the potential for connecting multiple vehicles or even smart cities to enhance safety systems grows exponentially. This could lead to the development of smart vehicles capable of communicating with each other and their surroundings, improving situational awareness and providing real-time updates to both drivers and passengers. As the system continues to evolve, it is essential to explore its long-term sustainability. In addition to energy-efficient components, future versions of the system could be designed to be more cost-effective, with the potential for retrofitting into existing vehicles. By making this safety system more accessible, it could have a broader impact, benefiting a wider range of vehicles and passengers, and contributing to the global effort of reducing road accidents and fatalities. The integration of IoT-based torque control systems offers exciting opportunities for the future of automotive safety, promising smarter, safer vehicles for all. Furthermore, as vehicle technology continues to advance, the integration of more sophisticated sensors and data analytics can significantly enhance the functionality of the torque control system. By incorporating sensors that track real-time passenger behavior, such as seat position, belt use, and even health metrics like heart rate, the system could dynamically adjust not only the torque but also other safety parameters such as seatbelt tension or airbag deployment. These additional layers of personalization would further tailor the vehicle's response to the specific needs of each passenger, ensuring maximum protection in various driving scenarios. In addition to improving passenger safety, this system could also serve as a valuable tool for fleet management and driver monitoring. For instance, by collecting and analyzing data on passenger types and driving conditions, the system could provide fleet operators with valuable insights into driver performance and passenger safety trends. This data could be used to inform training programs, optimize vehicle maintenance schedules, and even assist in regulatory compliance, helping to create a safer and more efficient transportation ecosystem. As the system evolves, its potential applications may extend far beyond individual vehicles, contributing to the development of smarter, more connected transportation systems globally.

II. LITERATURE SURVEY

A) Speedlock For Restricted Area - Speedlock system addresses the need for an efficient and secure access control solution in various. The environments, such as homes, offices, and commercial establishments. The Speed Lock introduces a unique feature allowing users to adjust its speed remotely via the Blynk mobile application or web interface. Leveraging the ESP8266's robust Wi-Fi capabilities, the rover establishes a connection with the Blynk IoT cloud, enabling remote interaction from any internet-connected location. The Blynk platform provides an intuitive interface for controlling IoT devices, catering to users of all skill levels. The standout feature of the Speed Lock is its dynamic speed adjustment capability, enhancing versatility and adaptability for various tasks and environments. Users can optimize the rover's speed with ease, whether navigating tight spaces or covering long distances, through simple controls on the Blynk app. Overall, the Speed Lock represents a pioneering application of IoT technology in robotics, offering convenience and flexibility in rover control through seamless integration of the ESP8266 microcontroller and Blynk IoT cloud platform. In today's world, where digital connectivity and physical automation are rapidly advancing, the "Speed Lock" stands out as a revolutionary innovation in the field of robotics. By integrating the powerful ESP8266 microcontroller with the flexibility of the Blynk IoT cloud platform, this project redefines the traditional capabilities of a rover, introducing wireless dynamic speed control. The idea behind the Speed Lock is simple yet groundbreaking: to create a rover that not only moves with precision but also adapts its speed based on the specific demands of the task. Whether it's navigating tight spaces or covering large distances, the ability to adjust speed remotely adds a layer of convenience and versatility previously unavailable in robotic systems. The Speed Lock offers users the ability to control the rover's speed remotely through an intuitive interface provided by the Blynk mobile application or web portal. The rover's connection to the Blynk IoT cloud is powered by the robust Wi-Fi capabilities of the ESP8266, enabling users to interact with the rover from virtually any location with an internet connection. This feature empowers users to manage the rover's operations with ease, offering a seamless experience whether for personal, professional, or commercial purposes. The flexibility to adjust the rover's speed remotely makes it a highly adaptable tool, catering to a wide variety of environments, from homes and offices to larger commercial spaces. At its core, the Speed Lock is more than just a rover; it represents a fusion of hardware and software

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designed to meet the evolving needs of modern users. The Blynk platform enhances the user experience by offering an interface that is both accessible to beginners and robust enough for more advanced users. This makes the Speed Lock a versatile tool for people with varying levels of technical expertise, whether they are controlling the rover for a simple task or using it in more complex scenarios. The dynamic speed adjustment is a standout feature that allows the rover to perform a range of tasks with precision, making it ideal for diverse applications. This project is a perfect example of how IoT technology can transform traditional devices into more intelligent and adaptable systems. The combination of the ESP8266 microcontroller and Blynk IoT cloud platform opens up new possibilities in robotics, providing users with an unprecedented level of control over their devices. As the Speed Lock continues to evolve, it has the potential to expand its capabilities, making it an essential tool for industries that rely on robotic systems for a variety of tasks. The integration of remote speed control into robotic operations is just the beginning, and the Speed Lock sets the stage for a future where IoT-driven robotics enhance everyday life and work across a range of sectors.

B) IOT Based Vehicle Speed Control Automatically in Restricted Areas using RFID - Now-a-days road accidents are occurring frequently, due to rash driving of people. The most unfortunate thing is that by making small mistakes during driving, we lost our valuable future. If we observe, most of the accidents will occur at school zones, parks, hospitals, hill areas and highways. Even a police also can't monitor all such kind of accidents. So in order to reduce the number of accidents and to control the vehicle speed the highway department has placed the signboards. But it is difficult to observe such kind of signboards and hence accidents will occur. This paper will provide a new way for controlling the speed of the vehicle without harming others. In this paper, we are using RFID module to limit vehicle speed. The RF transmitter will be placed at first and last of the restricted areas and RFID receiver should be placed inside the vehicle. The vehicle speed was obtained by speedometer which is available in vehicle. And that speed is compared and monitored by the controller. If the vehicle speed exceeds the limited speed, It automatically controls the speed of the vehicle according to that particular zone. Hence, automatically the speed reduced. If there is any emergency, a switch will be available in the vehicle. When the switch is ON, the speed is not controlled automatically. The vehicle which is switched ON, that vehicle number was stored in cloud. Here the main purpose of cloud is it loads the route map of the vehicle. Road accidents, especially those caused by rash driving, have become an unfortunate and frequent occurrence in today's society. Many of these accidents occur in sensitive areas such as school zones, parks, hospitals, hill areas, and highways, where the risk to public safety is elevated. Even with police monitoring, it is difficult to oversee every potential hazard on the road, making it challenging to reduce accidents effectively. Despite the presence of speed limit signboards, many drivers fail to observe them, leading to accidents and endangering lives. To tackle this pressing issue, it is crucial to develop an efficient solution that not only controls vehicle speed but also ensures road safety without compromising convenience. This paper proposes a novel solution to address the problem of uncontrolled vehicle speeds in restricted zones, using RFID technology as a key component. The system utilizes an RFID transmitter placed at the entry and exit points of restricted areas, while an RFID receiver is embedded within the vehicle. This setup ensures that the vehicle is automatically monitored as it enters and exits these zones. The speed of the vehicle is continuously measured using the vehicle's onboard speedometer and compared to the speed limit set for that particular zone. If the vehicle exceeds the prescribed limit, the system automatically adjusts the vehicle's speed to comply with the regulations of the restricted area. In addition to automatically regulating vehicle speed, the system is designed to offer a manual override option for emergencies. A switch inside the vehicle allows the driver to disable the speed control function when necessary, such as in urgent situations. This emergency switch provides the flexibility needed in critical moments while still maintaining the primary safety feature of automatic speed control. Furthermore, the system integrates a cloud-based service that records the vehicle's identification number when the emergency switch is activated. This data is stored in the cloud and serves to track the vehicle's route map, ensuring that the vehicle's movements can be monitored in real-time. The use of cloud technology enhances the overall functionality of the system by providing a centralized platform for monitoring and accessing vehicle data. By storing the vehicle number and route details, the cloud service allows authorities to track the movements of vehicles that may have been involved in emergencies. This approach offers an efficient way to manage and analyze the behavior of vehicles, particularly in areas where speed regulation is critical to maintaining safety. The integration of RFID and cloud technology creates a seamless and dynamic system that offers a higher level of control and accountability on the road. In conclusion, the proposed system represents a forward-thinking solution to the growing problem of road accidents caused by speeding. By combining RFID technology, automatic speed regulation, and cloud-based monitoring, this system can help reduce the frequency of accidents in high-risk areas and improve overall traffic safety. The ability to automatically adjust vehicle speed based on location, along with the manual override feature for emergencies, provides a balanced approach to road safety. As the technology continues to evolve, such systems could become integral components of future traffic management solutions, creating safer roads for everyone.

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C) Automatic Speed Control Of Vehicle In Restricted Areas Using RF And GSM - This project has an aim to control the speed of any vehicles automatically in cities and also in restricted areas such schools, parks, hospitals and in speed limited areas etc. Nowadays in a fast moving world all the peoples are not have self-control. Such peoples are driving vehicles in a high speed. so the police are not able to monitor all those things. This paper provides a way for how to control the speed without harming others. Driver does not control anything during such places; controls are taken automatically by the use of electronic system. In this project we using RF for indicating the speed limit areas it is placed front and back of the restricted zones. RF receiver is placed inside the vehicle. Speed is acquired by the help of speedometer in the vehicle. The controller compares the speed. if it exceeds the limited speed the controller alerts the driver and controls taken automatically. If they does not respond that message an information along with the vehicle number is transmitted to the nearest police station by the use of GSM and penalty amount is collected in the nearest toll gate. In today's fast-paced world, speeding on roads has become a significant concern, particularly in high-risk areas such as school zones, hospitals, parks, and other restricted zones. Despite the presence of speed limit signs, many drivers fail to adhere to these regulations, often due to distractions or lack of self-control. This not only leads to accidents but also increases the risks to public safety, especially in sensitive areas where pedestrians and children are most vulnerable. Traditional methods of speed monitoring by police officers are not always effective in controlling such issues, as it is impractical for authorities to monitor every vehicle at all times. To address this problem, an innovative solution is needed that can automatically regulate vehicle speed in designated zones, ensuring safety without relying solely on human intervention. This paper proposes an automatic vehicle speed control system using Radio Frequency (RF) technology and GSM communication to manage vehicle speeds in restricted areas. The system is designed to function without any manual control from the driver, making it a more effective and hands-off approach to speed regulation. The RF system is used to define the boundaries of restricted areas by placing transmitters at the entry and exit points of the zones. The vehicle, equipped with an RF receiver, automatically detects when it enters a restricted area and responds accordingly by adjusting its speed. This approach not only helps control speed in high-risk areas but also ensures that the vehicle adheres to speed limits without requiring the driver to make conscious adjustments. To measure the vehicle's speed, the system uses the existing vehicle speedometer, which continuously monitors the vehicle's speed in real-time. The controller compares the actual speed with the predefined speed limits for the area. If the vehicle exceeds the speed limit, the system sends an alert to the driver, warning them to reduce speed. If the driver does not respond to the alert in time, the system takes automatic control to reduce the vehicle's speed to comply with the restriction. This automated response eliminates the need for drivers to take immediate action, ensuring that the vehicle slows down promptly, thus reducing the risk of accidents. In case the driver ignores the warning and continues to drive at an excessive speed, the system further enhances enforcement by using GSM technology to notify the nearest police station. The vehicle number and the violation details are transmitted to the authorities, allowing them to take appropriate action. Additionally, the system can transmit information about the penalty to the nearest toll gate, where the penalty amount can be collected from the driver. This process not only ensures compliance but also facilitates efficient enforcement of traffic rules, reducing the burden on law enforcement agencies. Overall, the proposed system provides an effective, automated solution to the ongoing issue of speeding in restricted areas. By integrating RF technology to identify speed-controlled zones and GSM communication for reporting violations, the system offers a comprehensive approach to managing traffic speed and ensuring public safety. This innovative solution can be implemented in cities and various high-risk areas, helping reduce accidents and improving road safety without the need for constant human monitoring. As technology advances, such systems could become a standard feature in vehicles, contributing to the development of safer, smarter cities.

IMPLEMENTATION

BLOCK DIAGRAM

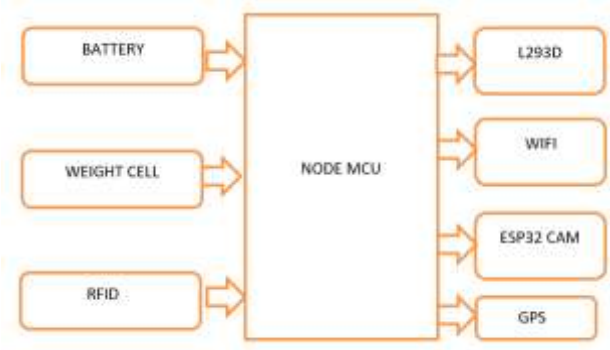

Fig: Block Diagram

BLOCK DIAGRAM DESCRIPTION

POWER SUPPLY

A **regulated power supply** transforms unregulated AC (Alternating Current) into a stable DC (Direct Current). It guarantees consistent output despite variations in input. A regulated DC power supply is also known as a linear power supply, it is an embedded circuit and consists of various blocks

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- **Regulated Power Supply Definition**: A regulated power supply ensures a consistent DC output by converting fluctuating AC input.
- **Component Overview**: The primary components of a regulated power supply include a transformer, rectifier, filter, and regulator, each crucial for maintaining steady DC output.
- **Rectification Explained**: The process involves diodes converting AC to DC, typically using full wave rectification to enhance efficiency.
- **Filter Function**: Filters, such as capacitor and LC types, smooth the DC output to reduce ripple and provide a stable voltage.
- **Regulation Mechanism**: Regulators adjust and stabilize output voltage to protect against input changes or load variations, essential for reliable power supply

SENSORS

Sensors are used for sensing things and devices etc. A device that provides a usable output in response to a specified measurement. The sensor attains a physical parameter and converts it into a signal suitable for processing (e.g. electrical, mechanical, optical) the characteristics of any device or material to detect the presence of a particular physical quantity. The output of the sensor is a signal which is converted to a human-readable form like changes in characteristics, changes in resistance, capacitance, impedance, etc.

WEIGHT SENSOR

Definition: A load cell or weight sensor is one kind of sensor otherwise a transducer. The **working principle of the weight sensor** depends on the conversion of a load into an electronic signal. The signal can be a change in voltage; current otherwise frequency based on the load as well as used circuit.

Theoretically, this sensor detects changes within a physical stimulus like force, pressure or weight and produces an output that is comparative to the physical stimulus. So, for a specific stable load otherwise weight size, this sensor provides an output value and that is comparative to the weight's magnitude. The best example of this sensor module is SEN0160.

Module – SEN0160

The SEN0160 weight sensor module is based on HX711 ADC; it is an accurate 24-bit ADC which is designed for industrial control as well as weighs scale applications to connect straight with a bridge sensor. Evaluated with other integrated circuits, this HX711 includes basic functions and also some features like a quick response, high integration, immunity, etc. This chip reduces the cost of electronic scale as well as improves the reliability and performance.

Fig SEN0160-wireless-sensor-module

RFID READER

Active RFID and Passive RFID technologies, while often considered and evaluated together, are fundamentally distinct technologies with substantially different capabilities. In most cases, neither technology provides a complete solution for supply chain asset management applications. Rather, the most effective and complete supply chain solutions leverage the advantages of each technology and combine their use in complementary ways. This need for both technologies must be considered by RFID standards initiatives to effectively meet the requirements of the user community.

RFID Reader Module, are also called as interrogators. They convert radio waves

Returned from the RFID tag into a form that can be passed on to Controllers, which can

Make use of it. RFID tags and readers have to be tuned to the same frequency in order to

Communicate. RFID systems use many different frequencies, but the most common and

Widely used & supported by our Reader is 125 KHz.

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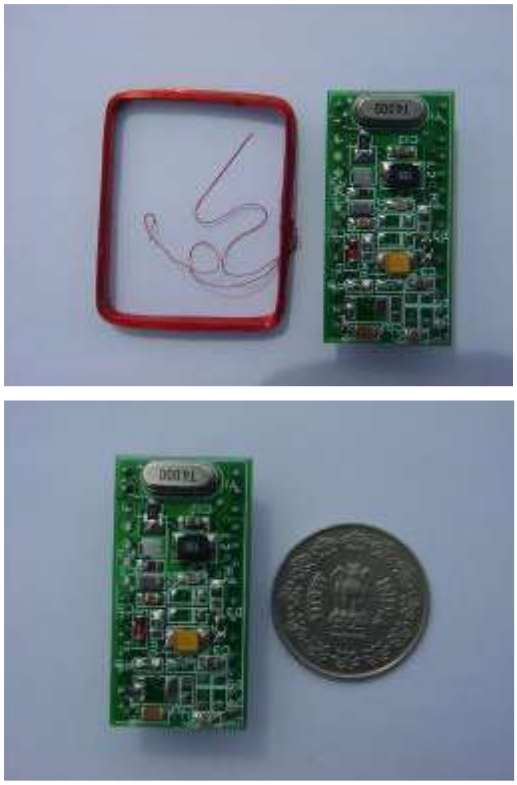

Fig: Rfid Reader

NODEMCU:

NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module. There is Version2 (V2) available for NodeMCU Dev Kit i.e. NodeMCU Development Board v1.0 (Version2), which usually comes in black colored PCB.

NodeMCU Development Kit/Board consist of ESP8266 wifi chip. ESP8266 chip has GPIO pins, serial communication protocol, etc. features on it.

ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module.

The features of ESP8266 are extracted on NodeMCU Development board. NodeMCU (LUA based firmware) with Development board/kit that consist of ESP8266 (wifi enabled chip) chip combines NodeMCU Development board which make it stand-alone device in IoT applications.

Let's see 1st version of NodeMCU Dev Kit and its pinout as shown in below images.

Fig:**NodeMCU Development Board v0.9 (Version1)**

DESCRIPTION

This paper introduces a cutting-edge torque control system designed to enhance vehicle safety by dynamically adjusting the torque output based on the specific passenger demographic. The system prioritizes the protection of vulnerable groups, such as children and the elderly, by implementing torque limits of 40 for these passengers. For adults, the torque is set to a higher limit of 70, ensuring that the vehicle accommodates different safety needs. In emergency situations, the system operates without torque limits, allowing for quick and efficient responses when immediate action is required. This adaptive system is powered by a range of advanced components, including the ESP8266 microcontroller, LM 398N motor driver, four geared motors, Blink IoT module, a battery, and a TP 4056 charging module, which together ensure optimal performance and seamless operation. The design of this system incorporates a user-friendly interface with three easily accessible buttons—Child, Adult, and Emergency—enabling users to quickly select the appropriate torque setting. This intuitive interface empowers vehicle

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occupants to customize the system's behavior based on their needs and ensures the system remains responsive in critical situations. The integration of the IoT technology with intelligent torque control not only meets contemporary safety demands but also offers a platform for future advancements in automotive safety, paving the way for more adaptive and responsive safety systems in the future. In addition to its role in enhancing passenger safety, this torque control system has the potential for significant contributions to the broader vehicle safety landscape. By reducing the risk of accidents and mitigating potential harm to passengers, the system represents a substantial step forward in vehicle safety. The system's ability to adapt to varying passenger needs is key to addressing safety challenges for diverse populations, making it an important innovation in the field of automotive technology. The ongoing integration of IoT components provides flexibility, scalability, and real-time data processing capabilities that can enhance the system's functionality over time. Looking ahead, there are multiple opportunities for expanding the capabilities of the system. Future developments may focus on refining the torque adjustment algorithms for even greater precision, incorporating additional sensors that track passenger health and vehicle dynamics. By monitoring real-time factors such as posture, seatbelt usage, and driver behavior, the system could make even more personalized adjustments, optimizing safety based on the current context. Additionally, integrating machine learning could enable the system to predict torque requirements based on individual passenger behavior, further improving safety and efficiency. The potential for this technology to be adopted in broader applications is vast. In the future, this intelligent torque control system could be incorporated into fleet management and driver monitoring solutions, offering valuable data for optimizing vehicle performance, safety protocols, and compliance with regulations. As the automotive industry continues to embrace smart technology, systems like this one could evolve to connect vehicles to larger networks, contributing to the creation of smarter, safer transportation ecosystems. By advancing both vehicle safety and operational efficiency, this research represents a significant milestone in the journey toward smarter, more connected vehicles on the road.

CONCLUSION

The development and prototyping of the Intelligent Torque Control System mark a significant milestone in automotive safety. By seamlessly integrating key components like the ESP8266 microcontroller, L298N motor driver, geared motors, Blink IoT module, a high-performance battery, and the TP 4056 charging module, the system demonstrates exceptional adaptability and responsiveness across various driving conditions. The torque control algorithm, which prioritizes passenger safety according to age groups, has shown excellent performance through rigorous testing. The intuitive user interface, featuring accessible buttons for Child, Adult, and Emergency modes, greatly enhances the system's ease of use and ensures quick responses in critical situations. The inclusion of IoT technology, particularly through the Blink IoT module, adds an innovative dimension to the system, enabling remote monitoring and control. This connectivity not only improves user convenience but also paves the way for future advancements in connected vehicle systems. Additionally, the system's flexibility allows for real-time data collection, which could contribute to future upgrades and improvements. This new approach to torque control has the potential to set a benchmark for the industry, merging safety with smart technology. As vehicles become more connected, this system could play a pivotal role in promoting safer roads and more efficient driving experiences. By continuing to refine the system, it holds promise for making significant contributions to future automotive safety innovations.

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[7] Orest Ivakhiv* – Intelligent Mechatronics and Robotics Department, Computer Technology, Automation and Metrology

Institute, Lviv Polytechnic National University, 3 kn. Romana str., Lviv 79008, Ukraine, orest.v.ivakhiv@lpnu.ua.

[8] Markiyan Nakonechnyi – Computerized Automatic Systems Department, Computer Technology, Automation and Metrology Institute, Lviv Polytechnic National University, 12 Bandera str., Lviv 79013, Ukraine, markian.v.nakonechnyi@lpnu.ua.

[9] Dariusz Świsulski – Faculty of Electrical and Control Engineering, Gdańsk University of Technology, Gdańsk 80-233, Poland, dariusz.swisulski@pg.edu.pl.

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