Irish Interdisciplinary Journal of Science & Research (IIJSR)
Volume 8, Issue 2, Pages 123-131, April-June 2024

A low-cost Wi-Fi Enabled Vehicle Speed Management System

Rijo Aagash A.[1*], Farhan B.[2], Rahul Bright Prince B.[3] & Ashly Beby M.L.[4]

[1,2,3]UG Student, [4]Assistant Professor, [1-4]Department of Electronics and Communication Engineering, Stella Mary's College of Engineering, Kanyakumari, Tamilnadu, India. Corresponding Author Email: rijoaagash@gmail.com[*]

DOI: https://doi.org/10.46759/IIJSR.2024.8214

Article Received: 19 March 2024 Article Accepted: 24 May 2024 Article Published: 28 May 2024

ABSTRACT

This proposed work presents the WiFi technology-based approach for dual WiFi module-based vehicle speed governance in the fledgling zones. The second WiFi module should be inside the car and the centralized transmitter in the middle of the limited area. The transmitter device sends speed limits and other information to the receiver unit, which dynamically controls speed within the zone. The WiFi transmitter acts as a command and control station and continuously reports zone-based enforcement and maximum value criteria. It meets the same standards with innovative algorithms that adapt to road conditions. The receiver module immobilizes the vehicle, so take action and spend to maintain the signaled speed. The scheme includes real-time data transmission and road condition adaptation. The WiFi-based system allows for scalable and low-cost speed restrictions in limited zones. Simulations and field tests show the system can reduce traffic, improve road safety, and boost transportation efficiency. Our road map may include adding sensors and communication protocols to position our system for any use case and increase its capability. Finally, using dual WiFi modules as vehicle speed control systems in restricted areas could solve traffic issues and defragment the transportation network. This paper is a positive step toward using technology to improve road safety and urban mobility.

Keywords: WiFi; Assistance system; Speed management system; Internet of Things.

1. Introduction

With the rising demands of road traffic and the increasing importance of managing traffic movements, there is a growing urgency for effective measures to control vehicle speed in restricted areas [1]. Specific measures must be implemented in areas such as school zones, construction sites, and residential streets to reduce risks to pedestrians and cyclists and to ensure the safety of workers.

Conventional methods of speed control, such as signboards and speed bumps, are inadequate in terms of their ability to make immediate adjustments in response to changing conditions and enforce regulations in real-time. This article introduces a novel approach to address this problem by utilizing two WiFi modules in cars to regulate their speed in restricted areas. This sophisticated system utilizes wireless communication technology to instantly transmit speed limit data from a central emitter to vehicles equipped with receiver modules [2]. An advanced system that delivers accurate and up-to-the-minute speed limit data to drivers promotes adherence to regulations, resulting in enhanced safety and optimized traffic movement in specified speed-controlled zones.

Speed governors equipped with WiFi provide a sophisticated method of regulating speed and offer multiple significant advantages. WiFi-based systems have the ability to adapt speed limits in real-time according to factors such as road conditions, pedestrian density, and time of day, unlike basic directional indicators or physical barriers [3]. This level of responsiveness enables law enforcement officials to enhance their precision, thereby effectively preventing numerous accidents and minimizing unnecessary traffic disruptions. Furthermore, by integrating readily available components like the ESP8266 microcontroller and motor driver, the suggested system becomes not only economical but also capable of expansion. This facilitates effortless implementation by authorities and smooth incorporation into pre-existing infrastructure. The system's modular structure enables stakeholders to customize options or select from pre-designed templates that are suitable for different usage and deployment scenarios. This paper presents the process of creating and assessing a prototype system that utilizes two WiFi modules to control the speed of vehicles in restricted areas [4]. The system's integration of wireless communication technology and complex control algorithms signifies notable progress in traffic management, road safety, and the establishment of safer environments for all individuals using the road. This paper aims to develop a system that utilizes WiFi modules to regulate the average speed of movement in restricted areas. The purpose of this system is to control the speed of vehicles in school zones, construction areas, and residential neighborhoods in order to improve safety and optimize traffic flow [5].

Urban and suburban areas commonly encounter ongoing difficulties in regulating vehicle speed within restricted zones such as school zones, construction sites, and residential neighborhoods. Despite the utilization of conventional traffic signage and speed bumps, fast-moving vehicles persist in presenting hazards to pedestrians, cyclists, and workers. Current speed control methods lack the capability to autonomously adapt to changing conditions and effectively enforce speed limits with accuracy and immediacy. In addition, traditional approaches frequently entail substantial upfront expenses, necessitate ongoing upkeep, and may result in user discomfort or inconvenience [6].

The persistent issue of speed control in managed zones is primarily caused by insufficient enforcement of speed limits, slow or non-existent real-time responses to environmental changes, and the reliance on costly or intrusive speed control measures. In order to tackle these difficulties, the suggested system utilizes two WiFi modules to transmit and receive speed-limit data instantaneously. The central emitter transmits speed limit information to vehicles equipped with receiver modules, guaranteeing that drivers receive current and precise speed limit data upon entering restricted areas. The system's capacity to adapt speed limits in response to current conditions improves the efficacy of speed control measures.

WiFi technology enables enhanced flexibility and responsiveness in comparison to conventional speed control methods. As an illustration, speed limits can be automatically modified during school hours or when construction work is underway, and subsequently restored to their regular limits during non-operational hours [7]. By maintaining this level of precision, speed control measures are implemented only when required, minimizing any disturbance to the flow of traffic while maximizing safety. The system's modular design allows for effortless customization and scalability. Authorities have the ability to customize the system in order to fulfill the particular requirements of various restricted areas, such as a heavily trafficked school zone during morning drop-off hours or a residential street with a significant amount of pedestrian activity. The utilization of easily accessible components such as the ESP8266 microcontroller also ensures that the system is economically viable, enabling its widespread implementation without requiring substantial financial resources.

The system utilizes wireless communication technology to deliver real-time and precise speed limit information to drivers, thereby encouraging compliance and improving safety in restricted areas. The system's modular and cost-effective design allows for easy adoption and integration into the current infrastructure, providing a practical solution to the ongoing challenges of speed control in managed zones.

2. Related Works

Various passive and active measures are used to enforce speed limits in areas where vehicle speed control is restricted, ensuring that drivers comply with the specified speed limits. These measures are crucial for improving road safety, particularly in areas with significant pedestrian activity or specific safety issues, such as school zones and construction sites. This literature survey examines the typical components found in current systems, with a particular emphasis on how well they work, any restrictions they may have, and the possibility of improving them through technological advancements [8].

Conventional traffic signs and road markings are the main means employed to communicate to drivers the maximum speed limits in restricted areas. These signs are stationary and exhibit a consistent speed limit that is applicable to all vehicles at all times. Research has indicated that the efficacy of these signs is highly dependent on the extent to which drivers adhere to and are conscious of them. Nevertheless, the fixed nature of these signs renders them incapable of adjusting to dynamic circumstances, such as fluctuating traffic levels or the occurrence of children during school hours. The absence of adaptability can lead to either excessively cautious speed limits that disrupt the flow of traffic or inadequate limits that fail to sufficiently safeguard pedestrians during periods of high demand [9].

Speed bumps and humps are frequently employed as physical barriers to enforce speed limits by compelling drivers to reduce their speed. These devices are strategically positioned within restricted areas to guarantee adherence. Although speed bumps and humps are successful in decreasing vehicle speeds, they possess various disadvantages. They can generate excessive noise and discomfort for both drivers and passengers, particularly when traversed at higher velocities [10]. Furthermore, specific road configurations and classifications may not be suitable for these devices, thus restricting their usefulness. Studies suggest that speed bumps are effective in reducing vehicle speeds. However, they can also result in heightened vehicle damage and potential delays for emergency response vehicles, which are required to significantly decrease their speed to navigate these obstacles. Speed cameras are becoming more prevalent in restricted areas to streamline traffic enforcement [11]. These cameras record images of vehicles that are surpassing the officially designated speed limit, enabling authorities to issue citations or impose other forms of punishment on violators. Speed cameras have been proven to effectively decrease instances of speeding and improve overall adherence to speed limits. Nevertheless, the efficacy of speed cameras can be impacted by various factors, such as the visibility of the cameras, public knowledge of their existence, and the regularity of enforcement. There is also a worry that these systems may be seen as tools to make money rather than safety measures, which could impact how the public views and accepts them [12].

Police officers conducting direct surveillance continue to play a crucial role in enforcing speed limits in restricted areas. Law enforcement officers regularly conduct patrols and utilize a range of tools, including radar guns, to monitor the speeds of vehicles and enforce speed limits through direct intervention. This approach enables prompt intervention against wrongdoers, encompassing the issuance of citations or warnings. Although police surveillance is effective, it requires a significant amount of resources and may not be a viable long-term solution for enforcing speed limits [13]. The presence of officers may also differ, resulting in inconsistent implementation and potential deficiencies in coverage. Recent technological advancements show potential for improving traditional speed control methods [14]. For instance, incorporating wireless communication technologies like Wi-Fi modules can offer immediate updates and adapt speed limits dynamically according to present circumstances. This approach can enhance existing measures by providing flexible solutions that can adapt to evolving traffic patterns and environmental conditions [15]. Utilizing components such as the ESP8266 microcontroller enables the creation of economical and expandable systems that can be seamlessly incorporated into the current infrastructure. These systems can offer uninterrupted monitoring and enforcement without requiring constant human supervision, which could result in more reliable and efficient speed control [16].

The existing system for regulating vehicle speed in restricted areas depends on a combination of traditional signage, physical barriers, automated enforcement, and police monitoring. Although these methods are generally successful, they do have certain constraints that can be overcome by incorporating contemporary technology. Future speed control systems can provide more dynamic, responsive, and efficient solutions to improve road safety and ensure compliance with speed limits by utilizing advancements in wireless communication and real-time data processing.

3. Proposed system

A technique is proposed to address the limitations of the current model and enhance vehicle speed control in restricted areas. This technique involves utilizing WiFi modules. The proposed system incorporates dynamic speed limit adjustments, real-time communication capabilities, and the ability to respond to changes in road conditions. This enhances road safety and facilitates traffic management in restricted areas. The Centralized Transmitter Unit is located at the control center within the STZ. It is equipped with wireless streaming capability and sensors to measure mile-per-hour (MpH) limits and other relevant information. The transmitter consistently transmits signals to all vehicles within its coverage area, providing information on the speed limit and any updates, such as those related to weather conditions or road construction.

The Arduino board serves as the primary computing unit in the speed control system of this motorcycle. The system operates by utilizing the speed limit data received from the ESP8266 receiver module. It then analyzes the information and generates commands to modify the vehicle's speed based on the processed data. Dedicated Vehicles are equipped with transmitter units that receive signals from the Centralized Transmitter Unit for pickup. These modules serve as the recipient that interprets the speed limit information and retransmits the message to the engine. The engine modulates the velocity of the vehicle in response to the dynamically transmitted message.

The ESP8266 microcontroller functions as the primary data processor for both the transmitter and receiver. The ESP8266 facilitates data transfer between transmitters and vehicles equipped with receiver modules, enabling communication across various aspects. The motor driver is integrated into the vehicle's engine control system to instruct the receiver module to adjust the engine's speed. The motor driver regulates the power of the motor, allowing the vehicle to execute commands based on the received speed limit information. Chassis and structural components are essential for providing support and housing for the integrated physical components of a vehicle. They also play a crucial role in ensuring the durability and stability of the vehicle.

3.1. Block diagram

The vehicle speed control system is an approach that addresses accidents in restricted areas by regulating the speed of cars in those areas. The ESP8266 module serves as the central control unit of the system, responsible for collecting data from the sensors in the vicinity and transmitting them wirelessly to the network. These sensors are installed to detect signals or blurred areas and are used by someone who wants to receive notifications about the proximity of vehicles. The sensors are connected to an ESP8266 module, which activates the speed control system.

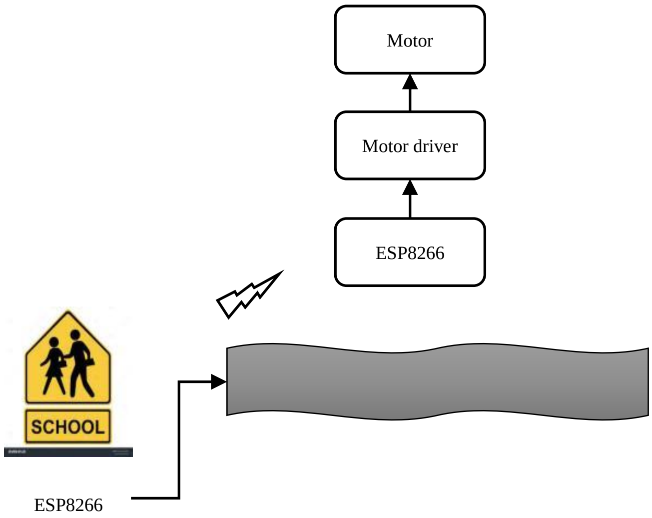

Figure 1. Block Diagram of Vehicle Speed Control

When the module interprets sensor data and detects signals of vehicles starting to move towards the forbidden zones, it activates the motor driver to control the throttle mechanism. Figure 1 shows the purpose of this motor driver is to consistently alter the speed of the vehicle by adjusting the throttle inputs, in conjunction with the motor. Regulating the oil market will lead to increased efficiency by implementing opinion control algorithms. By implementing these algorithms, it will be feasible to decrease the speed of vehicles to a safe level, resulting in a reduction in the occurrence of accidents.

The system's deceleration mechanism will adjust its operation to match the predetermined parameters of the system. It will adapt flexibly to accommodate your specific road speed conditions and the particular zone, based on the given requirements. The system dynamically adjusts the power output, whether it is a gradual reduction or a sudden deceleration, in order to comply with safety and speed regulations. This optimization is achieved in a timely manner.

The robot-assisted surgery system in medical specialties includes an emergency override function. By equipping each vehicle with a manual override switch, drivers have the option to temporarily bypass the speed control mechanism and regain full control of the vehicle. This proposed system offers an innovative, proactive, and comprehensive approach to regulating vehicle speed in controlled zones. It utilizes advanced solutions like wireless communication and motor control. Due to the system's automatic reduction of vehicle speeds to the specified limit, a majority of vehicle accidents are prevented. This promotes safer road usage practices for all motorists, ultimately resulting in improved road safety.

4. Results and Discussion

This research provides a detailed explanation of the final output of the vehicle speed control system utilizing a WiFi module. Two WiFi modules are utilized, one for transmission and the other within the vehicle. The images effectively illustrate the vehicle speed control system.

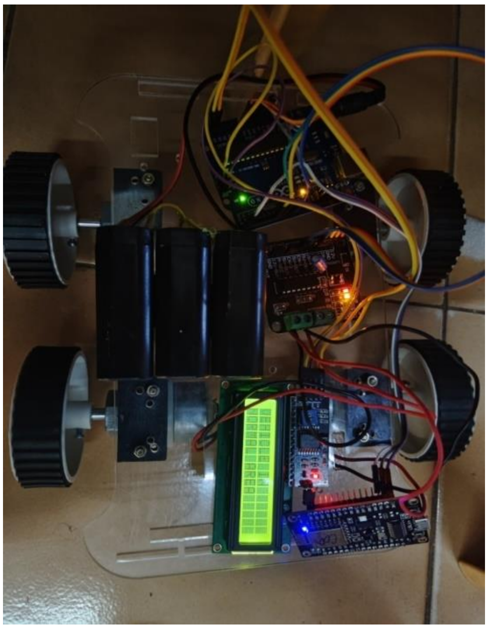

Figure 2. No restriction set in Vehicles

Figure 2 illustrates the scenario where the vehicle is located in typical regions. Currently, there are no limitations on speed. Upon entering restricted areas, the vehicle's speed is regulated. The location in question is designated as a speed-restricted area, and it is equipped with a WiFi module that functions as a transmitter. The signal is transmitted to the vehicle, resulting in the control of its speed.

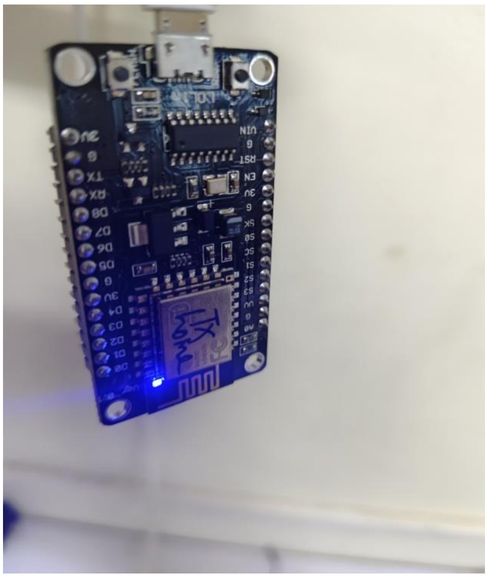

Figure 3. Transmitter in Restricted area

The image depicted in Figure 3 is the WiFi module utilized in areas with speed restrictions.

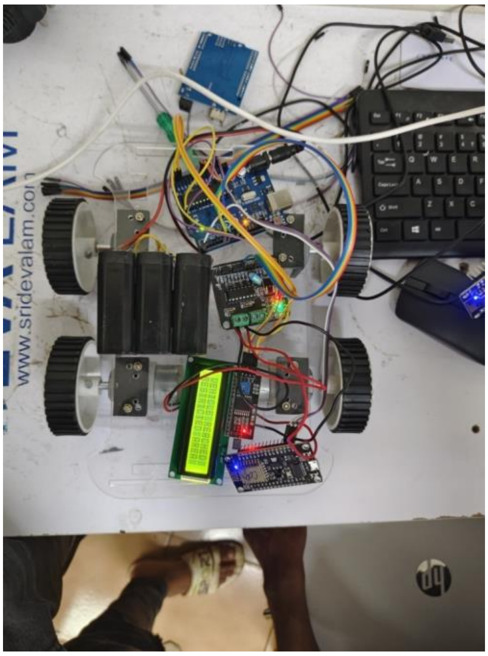

Figure 4. Vehicle when it's in a restricted area

Figure 4 depicts the operational capabilities of the system within a region where speed is limited. Upon entering the restricted zone, the vehicle promptly decelerates, conforming to the specified speed limit. After the vehicle leaves the restricted area, its speed reverts to its usual rate. The proposed system's ability to dynamically adjust is a fundamental characteristic that provides numerous notable benefits.

Our solution guarantees the automatic adaptation of vehicle speeds according to the present traffic density, road conditions, and other pertinent factors. This flexibility enhances road safety by mitigating the likelihood of accidents in high-risk locations, such as school zones and construction sites. Moreover, the system facilitates more efficient traffic circulation in limited zones, reducing congestion and improving the overall flow of vehicles. The incorporation of the ESP8266 microcontroller, in conjunction with WiFi modules, facilitates seamless integration of the proposed solution into preexisting vehicle systems. These readily available off-the-shelf components are not only cost-effective but also greatly reduce deployment costs. The ease of integrating this system enables swift implementation, enabling authorities to promptly improve road safety measures.

The system's modular design architecture enables scalability to accommodate different sizes and configurations of restricted areas. The ability to adapt the system to various settings, ranging from narrow residential streets to expansive construction zones, is of utmost importance. Moreover, the system's modular design allows for easy incorporation of future updates and enhancements, guaranteeing its continued effectiveness in keeping up with evolving technologies and requirements. Utilizing WiFi technology and readily available components to implement this approach provides a cost-effective alternative to conventional speed control methods. Traditional approaches, such as the use of speed bumps and traffic cameras, frequently result in substantial expenses for maintenance and operations in the long run. On the other hand, the suggested system reduces these costs, offering a cost-efficient solution that upholds superior levels of performance and dependability. The proposed vehicle speed control system offers a sophisticated, versatile, and cost-effective approach to managing vehicle speeds in restricted areas. Through the utilization of contemporary technology and a strong emphasis on seamless integration, the system guarantees a substantial improvement in both road safety and traffic efficiency.

5. Conclusion

The implementation of a vehicle speed controller has led to a notable enhancement in road safety and a reduction in the risks associated with speeding. This system offers a practical solution for managing vehicle speeds in restricted areas by utilizing advanced technologies such as motor drivers, ESP8266 modules, and proximity sensors. Through the use of emergency override capabilities and automated speed control systems, drivers can navigate specific areas more effectively and confidently, reducing the likelihood of accidents and promoting the adoption of safer driving practices. Furthermore, the vehicle speed controller's versatility and adaptability make it extremely well-suited for various applications, including hospitals, school zones, and areas with heavy traffic. The ability to adapt vehicle speeds in real-time based on current conditions and the proximity of hazards demonstrates the transformative potential of this technology in improving road safety. In the future, it will be crucial to continue conducting research and development efforts to refine and optimize this technology, ensuring that it reaches its full potential and gains widespread acceptance. This will ultimately benefit both pedestrians and motorists.

Declarations

Source of Funding

This study did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis and manuscript writing equally.

References

[1] Berhanu Yetay, Esayas Alemayehu & Dietrich Schröder (2023). Examining car accident prediction techniques and road traffic congestion: a comparative analysis of road safety and prevention of world challenges in low-income and high-income countries. Journal of Advanced Transportation.

[2] Jagatheesaperumal, Senthil Kumar, Simon Elias Bibri, Jeffrey Huang, Jeyaranjani Rajapandian & Bhavadharani Parthiban (2024). Artificial intelligence of things for smart cities: advanced solutions for enhancing transportation safety. Computational Urban Science, 4(1).

[3] Mallik Manjarini, Ayan Kumar Panja & Chandreyee Chowdhury (2023). Paving the way with machine learning for seamless indoor-outdoor positioning: A survey. Information Fusion, 94: 126–151.

[4] Upendra Modem, Varun Reddy & Safa, M. (2024). Smart GPS Based Vehicle Speed Limit Controller on zone identification using Geo-Fencing Algorithm. In 2024 3rd International Conference for Innovation in Technology (INOCON), Pages 1–6.

[5] Benmessaoud Youssef, Loubna Cherrat & Mostafa Ezziyyani (2023). Real-Time Self-Adaptive Traffic Management System for Optimal Vehicular Navigation in Modern Cities. Computers, 12(4): 80.

[6] Kunduru Arjun Reddy (2023). Cloud BPM Application (Appian) Robotic Process Automation Capabilities. Asian Journal of Research in Computer Science, 16(3): 267–280.

[7] Suresh Kumar, K., Radha Mani, A.S., Sundaresan, S., & Ananth Kumar, T. (2021). Modeling of VANET for future generation transportation system through Edge/Fog/Cloud computing powered by 6G. Cloud and IoT-based vehicular ad hoc networks, Pages 105–124.

[8] Majumder Abhradeep, Ashok Kumar Gupta, Partha Sarathi Ghosal & Mahesh Varma (2021). A review on hospital wastewater treatment: A special emphasis on occurrence and removal of pharmaceutically active compounds, resistant microorganisms, and SARS-CoV-2. Journal of Environmental Chemical Engineering, 9(2): 104812.

[9] Pisano Paul A., & Lynette C. Goodwin (2004). Research needs for weather-responsive traffic management. Transportation Research Record 1867, No.1, Pages 127–131.

[10] Advani Nainesh, Het Danak, Manish Dutta & Suprava Jena (2024). Spherical Cap Studs: A novel speed bump alternative to reduce discomfort with effective speed reduction. Traffic Injury Prevention, 25(2): 228–236.

[11] Kumar Suresh, K., Kishore Kumar, V., Ilamparithi, T., Boselin Prabhu, S.R., & Dinesh Kumar, R. (2020). Emerging Trends and Research Issues on Blockchain Technology for 5G-Enabled Industrial IoT. Blockchain Technology, Pages 219–235.

[12] Elfahim Omar, Marouane El Midaoui, Mohamed Youssfi & Omar Bouattane (2023). Traffic violations analysis: Identifying risky areas and common violations. Heliyon, 9(9).

[13] Al-Ahmadi Hassan, M. (2023). Analysis of Traffic Accidents in Saudi Arabia: Safety Effectiveness Evaluation of SAHER Enforcement System. Arabian Journal for Science and Engineering, 48(4): 5493–5506.

[14] Abdullah Shekh, Mohd Nashrul Bin Mohd Zubir, Mohd Ridha Bin Muhamad, Kazi Md Salim Newaz, Hakan F. Öztop, Md Shadab Alam & Kaleemullah Shaikh (2023). Technological development of evaporative cooling systems and its integration with air dehumidification processes: A review. Energy and Buildings, 283: 112805.

[15] Makhoul Nisrine, Dimitra V. Achillopoulou, Nikoleta K. Stamataki & Rolands Kromanis (2023). Adaptive pathways using emerging technologies: Applications for Critical Transportation Infrastructure. Sustainability, 15(23): 16154.

[16] Gerber Michael, A., Ronald Schroeter & Bonnie Ho (2023). A human factors perspective on how to keep SAE Level 3 conditional automated driving safe. Transportation Research Interdisciplinary Perspectives, 22: 100959.