DOI: 10.7251/JTTTP2401042R
UDC: 656.1.022.4:519.857

PROFESSIONAL PAPER

Autonomous vehicles in road traffic

Boris Z. Ribarić
SMATSA, (borisribaric87@hotmail.com)

Snježana Rajilić
Panevropski univerzitet, Saobraćajni fakultet - APEIRON, Banja Luka, (snjezanarajilic@yahoo.com)

Зоран Рибарић
SMATSA - Ваздухопловна Академија, Београд,(zoran.ribaric1958@gmail.com)

Received: March 25, 2024
Accepted: April 1, 2024

Abstract: The tendencies in further technological development and across all branches of industry are well-known worldwide, with a focus on the advancement of robotics and artificial intelligence. Over the years, there has been significant progress in the development of robotics, coupled with increased human awareness of its potential applications. Consequently, we find ourselves in a period where the commercialization and widespread utilization of artificially intelligent machines in human environments have become a reality. Among the significant applications of robotics in human lives is the utilization of robotic vehicles, commonly referred to as autonomous vehicles, in traffic management.

The implementation of new technologies aims to address various challenges in transportation, including congestion reduction, cost optimization, safety enhancement, and mitigation of environmental impact. This endeavor involves the integration of telecommunications, electronics, and informatics with traffic engineering principles for effective planning, design, and management of traffic systems. Such integration leads to improved efficiency and safety within the traffic system, while also yielding positive environmental outcomes.

Keywords: information integration, artificial intelligence, autonomous vehicles, road traffic, robotic vehicles

INTRODUCTION

The concept of autonomous vehicles encompasses all vehicles that operate without the need for a driver, commonly referred to as automated vehicles, robotic vehicles, or self-driving vehicles. In real-time driving, all functions of these vehicles are managed by the Vehicle Automation System. The passenger's role is solely to select a destination without intervening in the driving process. Autonomous vehicles rely on a database containing real-time maps and roads, which require continuous updates. Utilizing this data, autonomous vehicles process information to determine the optimal route and permissible speed.

During self-management and interpretation of information while steering, autonomous vehicles utilize various sensors such as video cameras, radar sensors, and laser rangefinders, in conjunction with the database maps, to detect other vehicles in traffic. Continuous data collection from the vehicle's immediate environment includes monitoring its position relative to lane markings, while other sensor systems determine distances and travel speeds between detected vehicles on the road.

Advanced automated vehicles possess the capability to update maps based on sensor input, including radar, lidar, GPS, and machine vision, allowing them to navigate through environments not defined in maps. Autonomous vehicles offer several advantages and perspectives, including:

- Significantly reducing traffic accidents compared to human drivers due to the continuous exchange of data, minimizing human error.
- Increasing the capacity of road routes by maintaining controlled distances between vehicles.
- Managing traffic flow effectively, thereby reducing overall driving time.
- Enabling greater utilization of speeds beyond prescribed limits.
- Decreasing the demand for parking space.
- Streamlining traditional road and traffic signals by obtaining information electronically. (1)

PRACTICAL APPLICATION OF AUTONOMOUS VEHICLES IN ROAD TRAFFIC

The advent of this new technology is anticipated to significantly alter people's fundamental perspective on road accidents. V2V (vehicle-to-vehicle) technology represents a revolutionary advancement, albeit accompanied by concerns regarding potential conflicts in the wireless spectrum necessary for communication. Should vehicles share this spectrum and encounter signal jamming, the circuits designed to provide warnings may fail to receive alerts, potentially leading to collisions. Moreover, the public may raise privacy concerns, as such technology could enable tracking of drivers and their driving behaviors.

Over the past decade, the rapid development of road transport has necessitated the utilization of information systems, paving the way for the emergence of driverless vehicles, also known as autonomous vehicles.

The integration of traffic infrastructure aims to enhance safety by facilitating V2V and vehicle-to-road station communications via short-range communication (DSRC) technology.

Additionally, through the implementation of communication systems such as V2V and V2I (vehicle-to-infrastructure), vehicles can preemptively address sudden scenarios, such as the need for deceleration due to vehicles ahead slowing down. This system allows a vehicle entering a speed-limited zone to transmit information to the following vehicle, alerting it to the impending slowdown and enabling the onboard computer to adjust speed accordingly. Such communication proves crucial, particularly in areas like rural highways with high traffic volumes, including near schools, where vehicles often travel at faster speeds compared to urban areas. Furthermore, proper placement of vertical signage, such as signs indicating speed limits, is essential to facilitate timely vehicle deceleration and speed adjustment within designated areas. These signs provide the vehicle's control computer with crucial information regarding speed limit changes.

PROPOSAL OF SUBSYSTEM FOR AUTONOMOUS VEHICLES IN ROAD TRAFFIC

Existing speed limiting solutions primarily focus on warning systems. However, a novel approach involves integrating a dashboard display onto the road surface in areas with restricted vehicle movement, as illustrated in Figure 1: a software block diagram based on the vehicle speed regulation system.

Communication among sensors, the control computer, and the actuators—the action initiators—is facilitated through software. The camera, positioned on the front of the vehicle or within the middle rearview mirror, serves as a primary component. This camera utilizes sign recognition capabilities to provide essential information to the software. Subsequently, the software processes this information and transmits it to the control unit, which activates the appropriate actuators based on the received data.(2)

This new technology is expected to significantly reduce traffic accidents and alleviate congestion. An innovative suggestion involves implementing priority lanes equipped with electric vehicle charging technology beneath the road surface. These specialized "green" pavement lanes, fitted with induction coils, allow electric cars to recharge while in motion. Utilizing such lanes would continuously replenish the vehicle's battery via induction, eliminating the need for frequent stops to recharge—an issue commonly faced by electric vehicles.

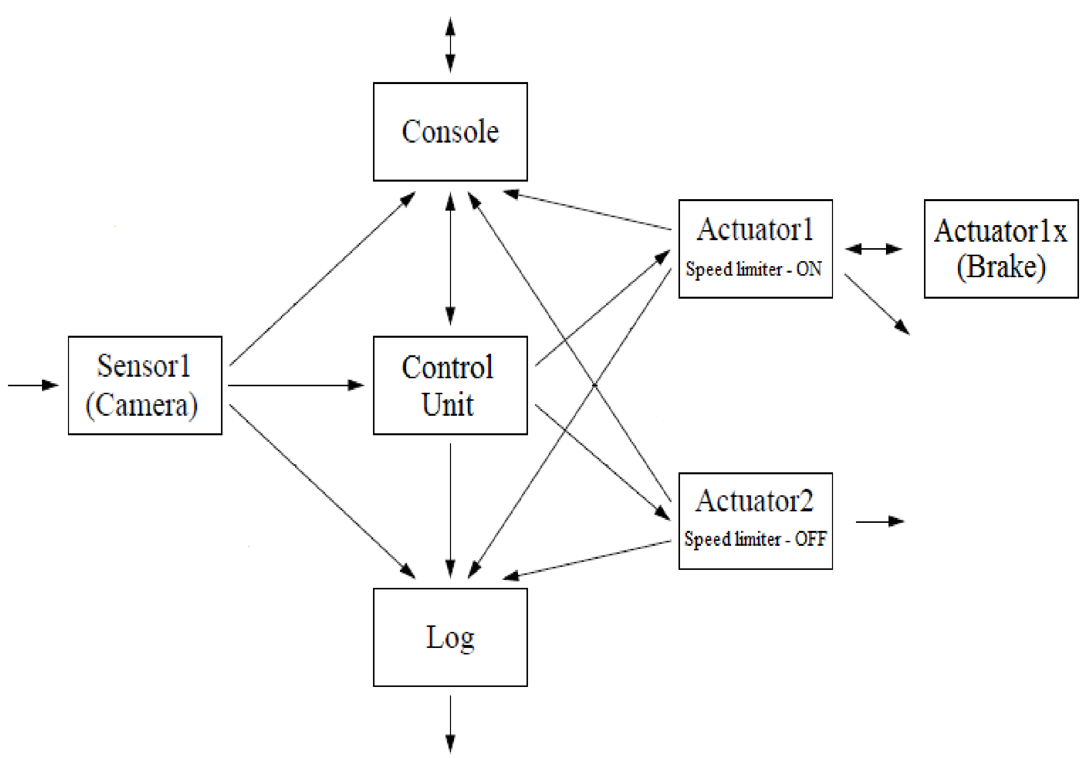

Figure 1: software block diagram based on the vehicle speed regulation system

Over the past decade, the development of road transport has witnessed significant advancements in capacity, technical features, safety measures, comfort, environmental standards, and transport economy. Improvements in autonomous vehicles contribute to traffic safety by enabling error-free driving through meticulous calculation of all relevant factors. Innovative technologies, such as roads illuminated in darkness, dynamic paint, interactive lighting, and priority inclusion lanes, aim to enhance road visibility while conveying crucial information directly onto the road surface.

Key elements of this system include GNSS and communication satellites, ground stations for data reception and processing, a ground system for road traffic monitoring, and information systems deployed within road transport units and central control units. The central control unit plays a pivotal role in receiving, processing, and disseminating information to all stakeholders within a unified road traffic system.

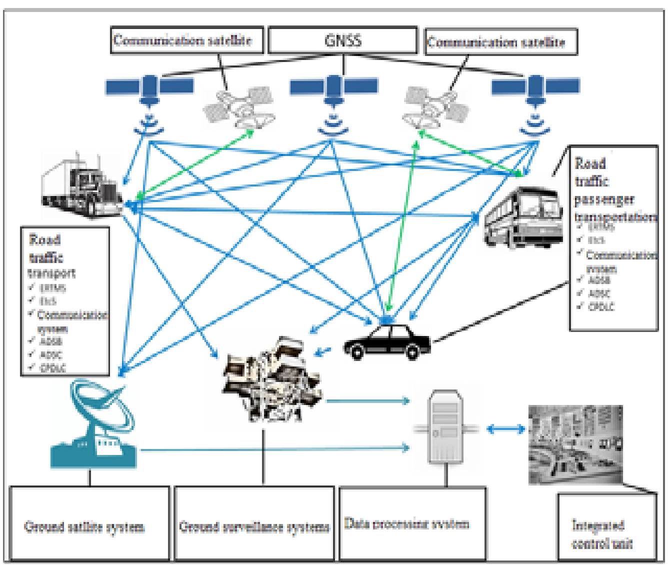

Figure 1: Integrated road traffic information system model

CONCLUSION

The fundamental task of traffic management is to utilize the capacitive capabilities of the traffic network in the most rational and efficient manner, aiming to provide quality service to the current traffic demand. This task becomes increasingly significant considering that the traffic network in the developed world has largely reached its "final" form (configuration and capacities).

This paper has presented the technology of utilizing autonomous vehicles. Alongside safety as an imperative, regularity and expediency are important. All these mentioned components are tied to economic efficiency and cost reduction, thus addressing the ecological aspect of gas reduction, environmental pollution, and ecology.

The new development of technologies will necessitate the standardization and automation of all functions-elements for safe, regular, and efficient traffic flow by continuously implementing supervisory components of the system and reducing risk factors through the use of autonomous vehicles.

Devices have been developed as elements to enhance safety in road traffic—autonomous vehicles. Their use is clearly defined by strictly prescribed technological applications. The need for using these devices is growing daily, as is their technological advancement in accordance with required new and planned safety factors that will enable increased capacity in road traffic.

The efficiency of traffic management is a strategic component of the overall system that will continue to evolve and keep pace with progress in the use of robotic vehicles or autonomous vehicles in traffic as one of the most important, of autonomous vehicles.

REFERENCES

[1] Zoran Ribarić, Informatička integracija vazdušnog i kopnenog saobracaja u sistemu avionskog prevoza putnika, doktorska disertacija, Panevropski univerzitet APEIRON, Fakultet informacionih tehnologija, Banja Luka, 2018 godina.

[2] Kajtez, M., Autonomna vozila: početak i primena robotizovanih vozila u saobraćaju, eRAF –elektronski dokument, Računarski fakultet, Beograd, 2014.

[3] Alladi, T., Chamola, V., Sahu, N., & Guizani, M. (2020). Applications of blockchain in unmanned aerial vehicles: A review. Vehicular Communications, 23, 100249.

[4] Meske, C., Bunde, E., Schneider, J., & Gersch, M. (2022). Explainable artificial intelligence: objectives, stakeholders, and future research opportunities. Information Systems Management, 39(1), 53-63.

[5] Gu, S., Zhang, Q., & Xiang, W. (2020). Coded storage-and-computation: a new paradigm to enhancing intelligent services in space-air-ground integrated networks. IEEE Wireless Communications, 27(6), 44-51.

[6] Allouch, A., Koubaa, A., Khalgui, M., & Abbes, T. (2019). Qualitative and quantitative risk analysis and safety assessment of unmanned aerial vehicles missions over the internet. IEEE Access, 7, 53392-53410.