



ECOTRON

WHITE PAPER

2023

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The Future of Automotive and Autonomous Controls

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The Future of Automotive and Autonomous Controls

Introduction

Traffic accidents, primarily caused by human error, are a global concern, accounting for over 1.3 million incidents annually. However, the rise of Advanced Driver Assistance Systems (ADAS) and autonomous driving technologies has significantly improved road safety standards. This progress has spurred the automotive electronics industry to develop components with enhanced computing power and performance to meet the evolving demands of automotive control systems.

By 2022, there were more than 1 billion vehicle owners worldwide, with nearly a quarter of them residing in the United States. American drivers spend an average of over 17,600 minutes per year behind the wheel. As autonomous driving technology and intelligent cockpits become more prevalent, drivers can enjoy hands-free entertainment, driving the demand for advanced driving experiences and further propelling the development of automotive electronics in intelligent network connectivity.

The move towards autonomous vehicles is also driven by energy conservation and emission reduction regulations, particularly stringent standards in regions like California. By 2025, California mandates that all cars and light trucks sold must achieve an average fuel efficiency of over 50 miles per gallon. These ambitious emission requirements are catalyzing the development of automotive electrification and boosting the electronic semiconductor industry's progress.

In response to these factors, automotive electronic control is undergoing significant transformations in the following areas:

1. **Evolution Towards Multi-Domain Controller:** Traditional automotive network architectures, featuring multiple Electronic Control Units (ECUs) connected in a distributed manner, are characterized by limited bandwidth and the need for individual ECUs for various functions. The increasing complexity of intelligent automotive networks necessitates a shift towards functional domain-based electronic architectures. This approach categorizes functions into five major domains: network connectivity, body comfort, autonomous driving, infotainment, and powertrain assembly. All data within these domains is managed and exchanged through a central gateway, enhancing the overall efficiency and information security of the vehicle's electronic control system. This architecture is evolving toward a virtualized network model, allowing central computing centers to virtualize surrounding controllers through software for rapid information processing.
2. **Drastic Advance in Vehicle Processor Computing Power:** As vehicles progress from assisted driving to autonomous driving, there is a heightened demand for computing performance in controller ECUs. For instance, Level 2 autonomous driving requires 20K DMIPS (million operations per second instruction execution) and 1 TOPS (trillion operations per second) of computing power, while Level 5 full autonomous driving necessitates over 200K DMIPS and 200 TOPS of arithmetic power.
3. **Growth in Sensor Performance and Quantity:** High-level autonomous driving requires advanced sensors, such as LIDAR and cameras, for accurate decision-making. Enhanced radar performance, particularly in terms of line-of-sight and detection accuracy, contributes to

improved path planning and overall driving safety. These sensor advancements are closely tied to the development of sensor chips.

4. **Implementation of 5G+IoT Technology:** Achieving autonomous driving relies not only on sensing and computing but also on 5G+IoT technology and cloud computing services. As 5G and IoT technologies advance, the progress of driverless and self-driving vehicles accelerates, offering more efficient, convenient, and secure networked vehicles.
5. **Increasing Demand for ADAS in Connected Cars:** The surging demand for Advanced Driver Assistance Systems (ADAS) in connected cars has laid the groundwork for a transformative automotive landscape. An essential component of this transformation is the shift towards Multi-Domain Controllers, a strategic consolidation of functions designed to optimize efficiency. This transition is made possible by the remarkable advancement in vehicle processor computing power, enabling the real-time execution of intricate algorithms crucial for ADAS operations.

Adding to this progress is the substantial growth in both sensor performance and quantity, encompassing LiDAR, radar, and cameras, all of which enhance the vehicle's perception capabilities. Furthermore, the integration of 5G+IoT technology represents a pivotal achievement, enhancing ADAS capabilities by enabling rapid data exchange and seamless vehicle-to-vehicle communication. This convergence of technologies heralds a new era characterized by heightened safety and convenience.

As demand continues its ascent, the automotive industry stands on the threshold of a redefined future, driven by the evolution towards Multi-Domain Controllers, propelled by robust vehicle processors, and elevated by the synergy of advanced sensors and 5G+IoT integration. This collective force is steering the industry towards an era of unprecedented innovation and efficacy.

6. **Information Security:** The future of intelligent network vehicles, although they serve as tools for travel, is distinct from mere supercomputers on wheels. These vehicles demand heightened functional safety and information security. Functional safety directly affects travel safety, while information security pertains to personal privacy. With the ongoing development of autonomous technology, functional safety faces increasing challenges, and information security confronts growing threats, significantly influencing the design of automotive electronic chip technology with regard to safety performance. Automotive electronic chips and associated control products not only meet conventional functional requirements but also ensure comprehensive functional safety and information security for the entire vehicle.

In the realm of sensor performance, millimeter-wave radar has undergone extensive enhancements encompassing frequency, semiconductor materials, and process technology. The millimeter-wave radar operates across frequencies of 24GHz and 77GHz, transitioning from SiGe to RF CMOS, and shifting from 40nm to 20nm technology. These advancements enhance radar integration, imaging capabilities, and recognition capabilities through deep learning. Future millimeter-wave radar is poised to evolve towards imaging functions, meeting the demands of accurate operation under diverse conditions.

Concerning vehicle entertainment and information systems, companies are increasingly incorporating AI-supported functions like voice recognition, gesture recognition, and face

recognition into their Imax series chips. This integration aims to provide customers with a comprehensive toolchain development environment.

In response to evolving needs and technical directions in intelligent network vehicles, the future automotive landscape resembles electronic products more than traditional automotive electronics. Internet-based car manufacturers pose substantial challenges to conventional Original Equipment Manufacturers (OEMs) and automotive electronics semiconductor companies.

Within the traditional automotive electronics control semiconductor field, leaders have proactively established early foundations in key areas such as sensors, Autonomous Driving Control Units (ADCUs), processors, and others. They have introduced innovative concepts and actual products, preparing to address the multi-faceted challenges and opportunities brought about by automotive electronics innovation in the context of intelligent networked vehicles.

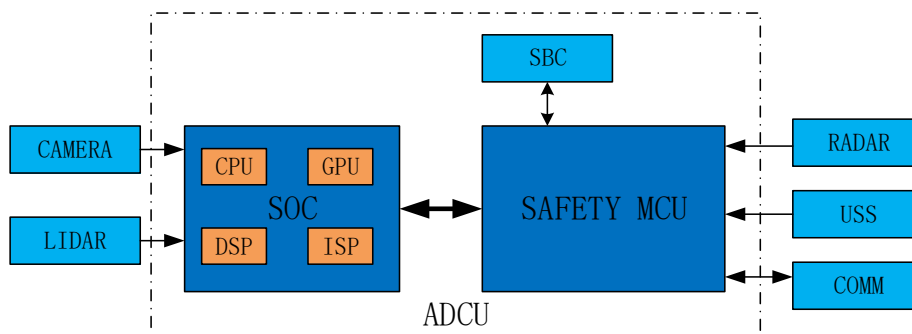
The automotive industry is undergoing a profound transformation, with vehicles becoming more like electronic products. Key developments include Multi-Domain Controllers, advancements in vehicle processor computing power, improved sensor technology, 5G+IoT integration, and a heightened focus on information security. These factors collectively drive innovation and efficiency, heralding an era of unprecedented progress in the automotive sector.

MCU (Micro-Control Unit)

Within the intricate landscape of modern Electric Vehicle (EV) and automotive systems, a Safety Micro-Control Unit (MCU) assumes a pivotal role. Specializing in logic operations within high functional safety contexts, the MCU acts as the linchpin for a range of essential functions. It takes responsibility for critical tasks like vehicle planning, control, communication, diagnosis, and the management of external I/O interfaces. Operating within the domain controller, the MCU ensures the seamless execution of these functions, contributing to the harmonious orchestration of the vehicle's diverse components. Serving as a vigilant overseer of operations demanding reliability and precision, the MCU upholds safety standards while facilitating real-time decision-making. Essentially, the MCU serves as a vital component in the wheelhouse of EV and automotive innovation, providing the intelligence and control necessary to navigate the complex landscape of modern vehicular systems with assurance and efficiency.

SOC + MCU

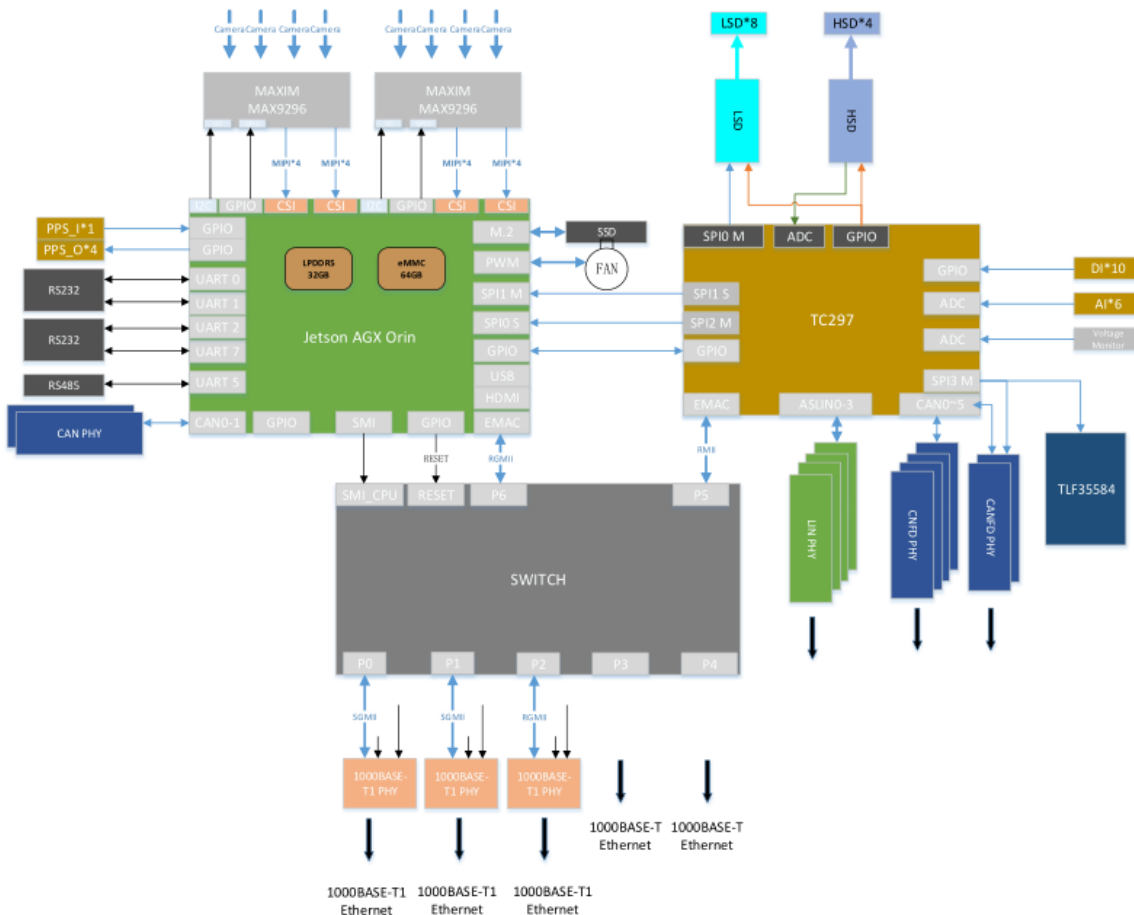
The classic framework of the autonomous driving domain controller consists of AI System on Chip (SoC) + Safety MCU, as illustrated below:



SoC (System on Chip) primarily handles tasks such as camera image data processing, laser radar point cloud data processing, and the generation of an output target recognition list through deep learning algorithms. It can also be used for sensor fusion, trajectory prediction, and other advanced functions.

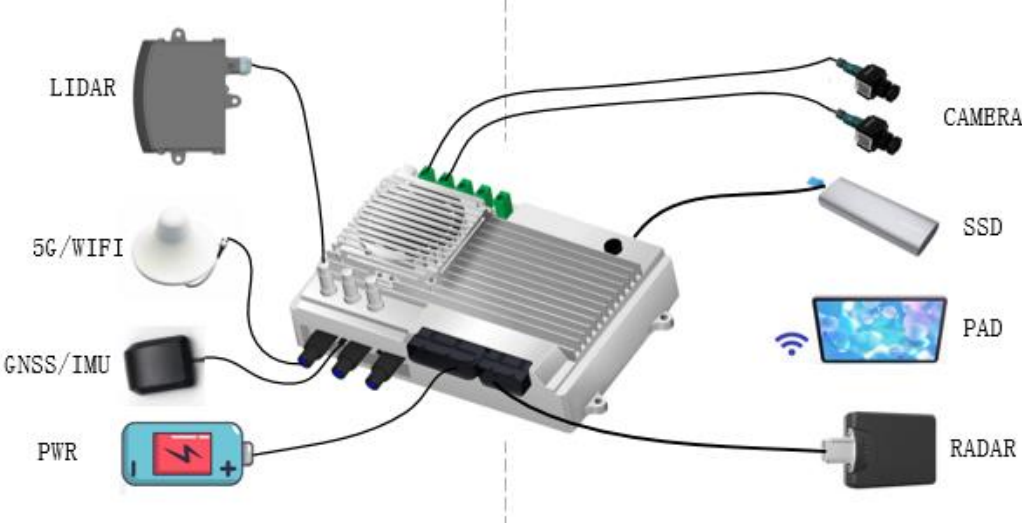
Safety MCU (Micro-Control Unit) is dedicated to logic operations under high functional safety levels, primarily overseeing vehicle planning, control, communication, diagnosis, and the external I/O interface controller within the domain controller.

Ecotron, in its development of intelligent vehicle driving and computing platforms, adopts a heterogeneous SOC+MCU design (as depicted below), delivering maximum computing power of up to 550+ TOPS. This architecture centers around an ASIL-D safety level MCU as the core processor, supporting perception, planning, and control functions with a strong emphasis on safety and computational prowess. Additionally, it has successfully undergone multiple tests related to protection and Electromagnetic Compatibility (EMC) in compliance with ISO16750 (Automotive electrical and electronic performance testing), ensuring high stability and reliability.



SOC is based on a GPU+CPU architecture, excelling in "large-scale and low precision" floating-point operations. It serves as the primary processing unit for perception tasks, including the processing of data from front-view, side-view, surround-view cameras, lidar, and inertial navigation systems.

The MCU manages millimeter-wave data and ultrasonic radar information while simultaneously functioning as the Controller Area Network (CAN) communication interface with the vehicle chassis. Moreover, during emergency situations, the MCU can rely on millimeter-wave radar to execute functions like Automated Emergency Braking (AEB) and other advanced features.



Best Applications for Autonomous Driving Control Unit

This collection of case studies highlights transformative endeavors in the realm of transportation and autonomy, each leveraging the power of Microcontroller Unit (MCU)-based technology.

Case Study 1: Advancing Electric Passenger Vehicles with MCU-Based VCU Structure

In this case, a leading Original Equipment Manufacturer (OEM) has ventured into electric passenger vehicles, utilizing MCU-based Vehicle Control Unit (VCU) architecture. These vehicles offer enhanced performance, extended range, and heightened safety, setting a new standard for urban mobility.

Case Study 2: Revolutionizing Electric Commercial Trucks with MCU-Based VCU Structure

A pioneering OEM has embarked on a journey to create electric commercial trucks with MCU-based VCU structures. These trucks deliver enhanced performance, efficiency, and safety, redefining the industry's standards for eco-friendly freight solutions.

Case Study 3: Transforming Resource Extraction with Autonomous Mining Trucks

This case explores the collaboration between a heavy equipment manufacturer and autonomous technology experts to create autonomous mining trucks. These vehicles revolutionize mining operations with increased efficiency, reduced downtime, enhanced resource extraction, and operational cost savings.

Case Study 4: Revolutionizing Urban Delivery with Autonomous Electric Vehicles

In a collaborative venture between a tech company and an electric vehicle manufacturer, autonomous electric delivery vehicles are introduced. They enhance delivery speed, reduce congestion, improve operational efficiency, and contribute to environmental sustainability.

Case Study 5: Pioneering Highway Autonomy with Autonomous Electric Commercial Trucks

Industry leaders' partner to develop Level 4 autonomous electric trucks for highway driving. This achievement results in fuel efficiency, safety advancements, operational reliability, and a redefined future for long-distance transportation.

These case studies collectively illustrate how MCU and MCU + SoC technology are reshaping various sectors, promoting efficiency, safety, and innovation, and promising a more sustainable and efficient future in transportation.

Case Study: Advancing Electric Passenger Vehicles with MCU-Based VCU Structure

Background: A leading Original Equipment Manufacturer (OEM), celebrated for its diverse vehicle portfolio, has ventured into the realm of electric mobility. The company's commitment to sustainable and efficient transportation solutions has culminated in the creation of electric passenger vehicles that seamlessly blend contemporary design with cutting-edge technology. These vehicles are meticulously engineered to address the evolving urban mobility landscape.

MCU-Based VCU Structure: At the heart of these electric passenger vehicles lies a sophisticated MCU-based Vehicle Control Unit (VCU) architecture. This innovative structure leverages a robust Microcontroller Unit (MCU) to orchestrate and optimize a myriad of vehicle systems. The result is a harmonious fusion of enhanced efficiency, safety, and performance, all essential in shaping the future of electric mobility.

Functionality: The MCU-based VCU structure in these electric passenger vehicles assumes a pivotal role by performing the following key functions:

1. **Battery Management:** It continuously monitors crucial battery parameters such as health, state of charge, and temperature, ensuring optimal performance and prolonged battery life.
2. **Drive Control:** The VCU regulates power delivery to the electric motor, resulting in seamlessly controlled acceleration and propulsion, which is vital for a comfortable and safe ride.
3. **Energy Optimization:** By intelligently distributing energy based on driving conditions, this structure enhances both range and overall energy efficiency. This is particularly beneficial for urban commuters.

Advantages:

1. Enhanced Performance: Thanks to the MCU-based VCU structure, these electric passenger vehicles offer precise control over power distribution, ensuring not only superior performance but also a smooth and exhilarating driving experience.

2. Extended Range: Effective energy management and optimization contribute significantly to an increased driving range. This makes these electric passenger vehicles an excellent choice for daily commuters who demand both practicality and sustainability.

3. Safety and Reliability: The integrated MCU constantly monitors critical vehicle systems, enhancing safety and reliability during operation. This proactive approach ensures that passengers and drivers alike can have peace of mind while on the road.

Incorporating the MCU-based VCU structure into their electric passenger vehicles, this prominent OEM has successfully navigated the ever-evolving landscape of electric mobility. Their commitment to sustainability, efficiency, and innovation has resulted in a new standard for urban transportation, one that combines modern design with state-of-the-art technology, promising a brighter, cleaner future for urban mobility.

Case Study: Revolutionizing Electric Commercial Trucks with MCU-Based VCU Structure

Background: A pioneering Original Equipment Manufacturer (OEM), renowned for its legacy in crafting robust commercial vehicles, has embarked on a transformative journey into the realm of electric trucks. These electrified behemoths are meticulously engineered to provide potent and eco-friendly solutions for the freight and logistics industry, cementing the OEM's status as an industry trailblazer.

MCU-Based VCU Structure: The foundation of these electric trucks' success lies in their advanced MCU-based Vehicle Control Unit (VCU) architecture. This innovative design harnesses the formidable power of a high-performance Microcontroller Unit (MCU) to orchestrate and optimize intricate vehicle systems. The outcome is a seamless blend of enhanced performance, energy efficiency, and safety, setting a new standard for electric commercial trucks.

Functionality: The MCU-based VCU structure in these electric trucks assumes a central role by executing the following critical functions:

1. **Battery Management:** It continuously monitors the vital statistics of the battery, including state, temperature, and health. This meticulous oversight ensures that the battery operates at peak performance levels, leading to prolonged battery life.
2. **Drive Control:** The VCU takes charge of power delivery to the electric motor, ensuring responsive acceleration and controlled propulsion. This is paramount for both maneuverability and safety.
3. **Energy Management:** By intelligently distributing energy in response to driving conditions, this structure optimizes both range and energy efficiency. This adaptability makes these electric trucks suitable for a spectrum of operational scenarios, from short haul to long-haul operations.

Advantages:

1. Enhanced Performance: The MCU-based VCU structure guarantees precise power delivery, translating into smooth acceleration and a noticeable boost in overall performance. This results in a driving experience that is not only efficient but also exhilarating.

2. Efficiency and Extended Range: Effective energy management is a game-changer, significantly extending the range of these electric trucks. This versatility means they are equally adept at short-distance hauls and long-haul journeys, promising efficiency and sustainability across the board.

3. Safety and Operational Reliability: The integrated MCU vigilantly monitors critical vehicle systems, thus enhancing safety and ensuring operational reliability, a particularly critical factor in the demanding world of commercial trucking.

By integrating the MCU-based VCU structure into their electric truck lineup, this pioneering OEM has reinvented the future of electric commercial trucks. Their unwavering commitment to power, sustainability, and innovation has resulted in a new era for the freight and logistics industry, where performance and eco-friendliness coexist harmoniously, ushering in a greener and more efficient era of transportation.

Case Study: Transforming Resource Extraction with Autonomous Mining Trucks

Background: An industry-leading heavy equipment manufacturer, celebrated for its unrivaled expertise in mining solutions, joined forces with autonomous technology pioneers to embark on a groundbreaking journey to revolutionize mining operations through automation.

Project Details: In this remarkable collaboration, the focus was on the development of autonomous mining trucks that could usher in a new era of efficiency, safety, and productivity within mining operations. The core of this transformation lay in the integration of Microcontroller Unit (MCU)-powered systems, boasting a blend of robust sensor arrays, GPS technology, and advanced control algorithms.

These integrated systems endowed the mining trucks with remarkable capabilities, enabling them to navigate the intricate and challenging terrains commonly found within mining sites. Moreover, these autonomous behemoths were tasked with the efficient and optimized transportation of essential materials within the mines, setting the stage for a seismic shift in resource extraction processes.

Outcomes:

1. **Efficiency and Safety:** Through meticulous testing and implementation, the collaborative effort successfully demonstrated the extraordinary potential of autonomous mining trucks in the demanding and often hazardous mining environments. These autonomous giants seamlessly adapted to the complexities of the terrain, leading to a marked improvement in operational efficiency and safety.
2. **Downtime Reduction:** One of the most remarkable outcomes was the substantial reduction in downtime, a persistent challenge in mining operations. Automation brought about a paradigm shift by enabling round-the-clock operation, thus optimizing resource extraction and overall productivity.
3. **Enhanced Resource Extraction:** The automated transportation of materials within the mines not only expedited operations but also significantly enhanced resource extraction. Materials could be efficiently transported from extraction points to processing facilities, reducing bottlenecks and ensuring a smoother and more efficient extraction process.
4. **Operational Cost Savings:** By reducing the reliance on human operators and enhancing operational efficiency, the introduction of autonomous mining trucks resulted in substantial cost savings over time. This financial advantage further solidified the business case for embracing autonomous technology in mining operations.

The collaboration between the heavy equipment manufacturer and autonomous technology experts marked a pivotal moment in the mining industry's evolution. By harnessing the power of MCU-based systems, sensor technology, and advanced algorithms, they successfully harnessed the potential of autonomous mining trucks. This achievement not only propelled efficiency, safety, and productivity to new heights but also underscored the critical role of automation in shaping the future of resource extraction. The legacy of this project continues to reverberate through the industry, offering a glimpse into a future where automation and innovation drive mining operations forward.

Case Study: Revolutionizing Urban Delivery with Autonomous Electric Vehicles

Background: In a groundbreaking collaboration, a pioneering tech company joined forces with a distinguished electric vehicle manufacturer, setting out on a mission to redefine urban delivery services through the power of autonomous electric vehicles.

Project Details: Together, they undertook the task of creating a fleet of compact, electric delivery vehicles that would serve as the vanguard of a transformative urban mobility solution. At the heart of these vehicles lay cutting-edge Microcontroller Unit (MCU)-based autonomous systems. These systems seamlessly integrated an array of advanced technologies, including sensors, GPS technology, and sophisticated algorithms, to craft a delivery experience that was not only highly efficient but also deeply eco-friendly.

These autonomous electric vehicles were meticulously designed to navigate the intricate and bustling urban environments that define modern cities. They promised to revolutionize the last-mile delivery process by introducing a new era of precision and sustainability.

Outcomes:

1. **Enhanced Delivery Speed and Reduced Congestion:** The successful deployment of autonomous electric delivery vehicles in urban environments ushered in a new era of urban logistics. These vehicles showcased their ability to navigate congested city streets with ease, reducing delivery times and minimizing the burden of traffic congestion. This had a positive ripple effect, contributing to reduced urban traffic congestion overall.
2. **Operational Efficiency:** The introduction of automation led to a profound enhancement in operational efficiency. Optimized route planning, aided by real-time traffic analysis, enabled deliveries to be executed with unmatched precision. Automated package handling streamlined the entire process, ensuring that parcels reached their destinations swiftly and securely.
3. **Environmental Benefits:** The adoption of electric vehicles coupled with autonomous technology had a profound impact on the environment. Urban deliveries, once notorious for emissions and noise pollution, took on a new, eco-friendly dimension. These autonomous electric vehicles significantly reduced the carbon footprint of urban delivery services, aligning perfectly with the global drive toward sustainability.
4. **Customer Satisfaction:** The amalgamation of speed, efficiency, and sustainability resonated with customers. The convenience of receiving packages more rapidly and reliably contributed to increased customer satisfaction and loyalty.

This collaborative venture between the tech company and the electric vehicle manufacturer revolutionized urban delivery services. By leveraging MCU-powered autonomous systems, they ushered in an era where speed, precision, and sustainability converged seamlessly. This case study serves as a testament to the immense potential of autonomous electric vehicles in shaping the future of urban mobility, promising a more efficient, eco-conscious, and customer-centric delivery ecosystem.

Case Study: Pioneering Highway Autonomy with Autonomous Electric Commercial Trucks

Background: In the dynamic landscape of autonomous driving, industry frontrunners are embracing the transformative potential of Microcontroller Unit (MCU)-based technology to redefine multiple sectors. This evolution spans electric trucks, delivery vehicles, mining trucks, and construction vehicles, creating a ripple effect of efficiency, safety, and innovation.

Application 1: Autonomous Electric Commercial Trucks on Highways

Project Details: In a remarkable collaboration, a trailblazing autonomous technology company, recognized for its groundbreaking contributions to self-driving solutions, joined forces with leading electric truck manufacturers. Their shared vision was to propel the evolution of autonomous trucking on highways, heralding a new era of road transportation.

The heart of this ambitious project lay in the development and deployment of Level 4 autonomous electric trucks specifically engineered for highway driving. These innovative vehicles were equipped with an array of advanced sensors, including LiDAR, radar, and cameras, all meticulously orchestrated by a potent MCU-based system.

Outcomes:

1. **Level 4 Autonomy:** The collaborative effort achieved an extraordinary milestone - Level 4 autonomy. This groundbreaking achievement meant that the autonomous electric trucks could navigate highways seamlessly, without the need for human intervention, within predefined highway scenarios. It was a testament to the power of MCU-driven autonomous systems in reshaping the future of road transportation.
2. **Fuel Efficiency Revolution:** The impact extended beyond autonomy. Real-time data processing, made possible by the MCU-based system, unlocked a treasure trove of efficiency enhancements. These included optimized speeds, following distances, and lane changes, all calibrated to maximize fuel efficiency. This not only represented a significant breakthrough but also aligned perfectly with the global quest for sustainable transportation solutions.
3. **Safety Advancements:** Safety remained a paramount concern throughout the project. The integration of MCU-driven autonomous systems led to a marked improvement in safety. The vehicles demonstrated the ability to make split-second decisions based on real-time data, reducing the likelihood of accidents, and enhancing overall road safety.
4. **Operational Reliability:** With human intervention no longer required for highway driving, operational reliability reached new heights. The autonomous electric trucks showcased consistent and dependable performance, a key factor in building trust and confidence in this transformative technology.

This collaborative venture between the autonomous technology company and electric truck manufacturers set a remarkable precedent. It showcased how the fusion of MCU-based technology, advanced sensors, and visionary engineering could redefine the possibilities of autonomous highway trucking. This case study exemplifies the innovative spirit of the industry, forging a path toward a future where autonomous electric commercial trucks play a pivotal role in reshaping the landscape of long-distance transportation.

Ecotron's Advanced Driver Control Units (ADCUs) represent the future of the autonomous driving industry. These cutting-edge devices incorporate powerful microcontrollers, advanced architectural designs, and state-of-the-art algorithms, positioning Ecotron products as the premier choice for your upcoming smart EV project. Learn more at: <https://ecotron.ai/adcu/>.