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Integration of AI-Driven Predictive Analytics into Connected Car Platforms

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Abstract: In this paper, we establish one key area where predictive analytics can bring value to the consumers of connected car platforms using state-of-the-art machine learning (ML) techniques such as long short-term memory (LSTM) networks. In addition to providing an idea of the kinks and challenges in the application and deployment of AI-driven predictive algorithms, we also describe some best practices that are essential to ensure that the AI-driven insights manifest themselves without compromising much on their accuracy and reliability. Though applied to the predictive insights associated with vehicle maintenance, the tools and practices described in this paper are generic. They can be used in similar contexts for predictive insights associated with other areas of connected car platforms. Connected car solutions have become one of the essential parts of the Internet of Things (IoT) and will continue to be a driving force behind innovation in the automotive industry. With the growth of Advanced Driver Assistance Systems (ADAS), in-car infotainment systems, and the continued evolution of automotive technologies targeting connected and automated driving, the industry is witnessing another wave of innovation in connected car platforms. Predictive insights can provide tangible value and benefits to the consumers of the connected car platforms. AI-driven predictive analytics bring great potential in harnessing connected car data to generate these valuable insights.

Keywords: Connected Car Platforms, Predictive Analysis, Industry 4.0, Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Smart Manufacturing (SM)

I. INTRODUCTION

Despite the challenges posed by the outbreak of COVID-19, global innovative vehicle sales are expected to increase by 29% to 31.3 million units in 2020, according to the latest global automotive report from the future mobility market research provider Canalys. The historical reasons for this growth can be traced to the steady increase in global travel demand. As mobility requirements rise, automobile and transportation infrastructures will also grow. This growth also enhances resilience mechanisms to restore transportation network functions and improve population access to transportation services.

Country / Region	Vehicle Sales		% Change (E)	Comments
	2019 (M Units)	2020E (M Units)		
China	25.7	21.9	-14.8%	Continues to make a V-shaped recovery
US	17.6	13.4	-23.9%	Sales continue to decline with the pandemic having a prolonged economic impact
Europe	18.3	13.6	-25.7%	Bounce back
Rest of World	28.4	23.0	-19.0%	Automakers resuming partial operations.
Total	90.0	71.9	-20.1%	Extended lockdowns and pressure on consumer confidence impacting sales.

Fig 1. EV Sales During the Covid

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Currently, an estimated 3 billion vehicles are on the road, with annual vehicle registrations in the United States expected to touch an estimated 74 million by 20401. To address pressing environmental concerns, developing alternative transport modes such as bicycle lanes, pedestrian walkways, and ride-hailing mobility has been recognized as a critical objective in developing and deploying connected car technologies. Using other shared modes of transport beyond personal vehicles can mitigate these adverse effects.

In the last two decades, there has been increased interest in developing connected and autonomous cars in response to the push to reduce accidents and fatalities. According to NHTSA (National Highway Traffic Safety Administration), "94% of serious motor vehicle crashes are due to human error," which leads to a great need to move this responsibility to technology as an attractive alternative. This has primarily been facilitated by introducing embedded characterization machines, sensors, and wireless technologies in modern cars into the broader Internet of Things (IoT) initiatives. These advancements have allowed for collecting and analyzing massive amounts of data, paving the way for integrating AI-driven predictive analytics into connected car platforms. This could further reduce crimes and car boarding break-ins, enhance rental car accuracy, draw younger customers who demand digital innovations and connectivity, and enhance pre-collision systems and the detection of diseases. It has continued to draw players involved in the business, including platform administrators, original equipment manufacturers (OEMs), and external technology providers. Despite the impressive progress in this domain, the absolute number of accidental deaths dropped in 2019 in the U.S. with a similar equity return.

II. BACKGROUND AND RELATED WORK

The Internet of Vehicles (IoV) concept marshals and enables numerous technologies that were previously independent of one another; the key technologies include (1) Wireless communications, (2) Real-time data processing and analysis, (3) Autonomous machines and robots, (4) Data and information management. In order to fulfill these technical trends above, this article will discuss how to integrate AI-driven predictive analytics into connected car platforms. Interethnic of A.I. and automotive has grown directly to the rise of autonomous driving, connected cars, smart cities, and high-speed 5G networks. A.I. and machine learning techniques can tap the value of massive data generated by driving situations related to traffic, vehicle management, and vehicle-to-everything technology. Machine learning uses historical and current traffic data, which plays a crucial role in predicting and detecting traffic accidents, reducing the time and increasing the forecast's accuracy. An Overview of AI-Based Approaches in the Automotive Sector Machine learning (ML) and deep learning (DL) typically have significant results in automotive applications due to their ability to learn from historical data and subsequently generalize the learning for future cases.

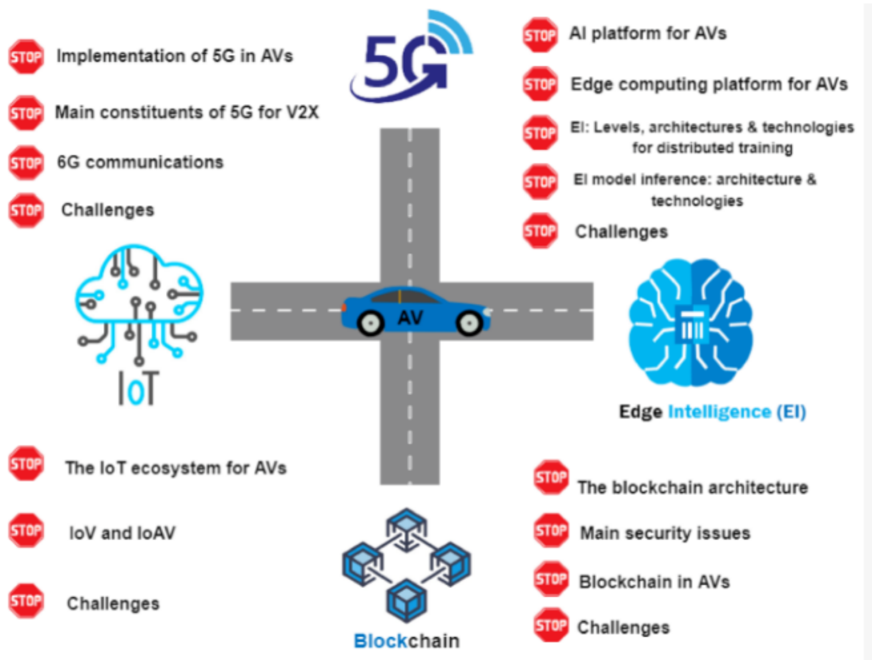

Fig 2. Innovations using 5G - Illustration.

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These techniques can ensure accurate learning of various driving scenarios and interpretation of driving features and advance the usage of A.I. and ML in autonomous vehicle decision-making. A survey asserts that AI-driven approaches based on ML and DL may improve automotive operations and increase the dependability of drivers and vehicle occupants by assisting in recognizing and forecasting dangerous driving conditions and occurrences. AI-driven predictive analytics can intensify vehicle operations and driver satisfaction. The automotive A.I. market is achieving prominence, contributing positively to the application of A.I. technologies in that regional market ecosystem. In April 2020, Ricardo PLC showed the IAMT 50 to interact with automated vehicles to perfect vulnerable road user operations in real-life and 3D driving environments.

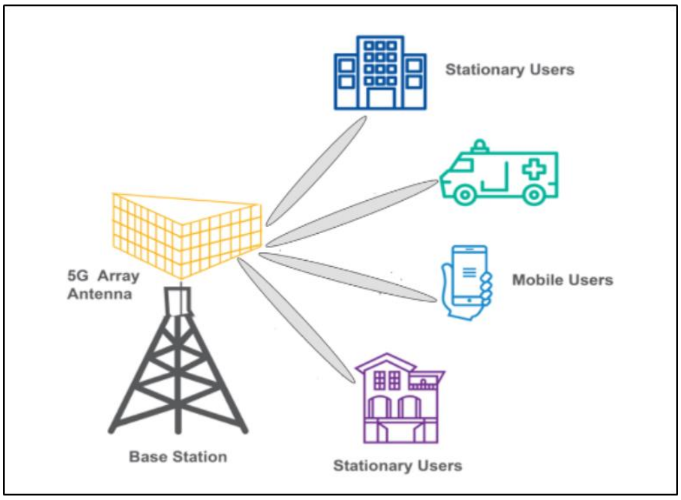

Fig 3. Beam Forming with 5G.

III. FRAMEWORK DESIGN

Recognizing societal interest and development in autonomous driving, significant work has been carried out in vehicle connectivity and sensor technology, incorporating multiple vehicle data generation and exchange for the improved driving experience. A deep learning implementation for energy-efficient computing considering the automotive applications using Convolutional Neural Networks;

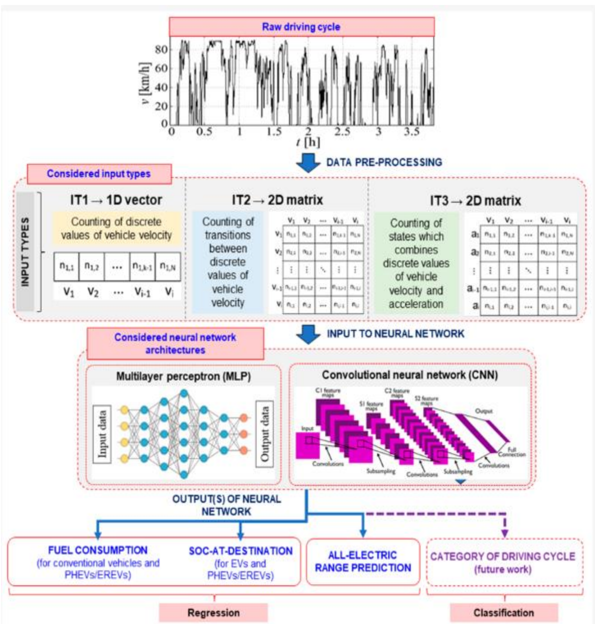

Fig 4. CNN View

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however, extensions in AI-based computational models and efficient real-time implementations are challenging, particularly in vehicular utilization. Two levels of vehicular data analytics, including on-board/on-vehicle and on-cloud data processing, are categorized. An exhaustive survey of on-device and on-cloud AI-based vehicular data analytics is carried out.A new strategy of approximate edge A.I. is discussed to maximize energy efficiency in autonomous driving and H.D. maps in connected cars. To make the approach energy efficient, this paper explained energy-efficient A.I. and deep learning approaches using approximate techniques suitable for use in autonomous driving services and connected vehicles.

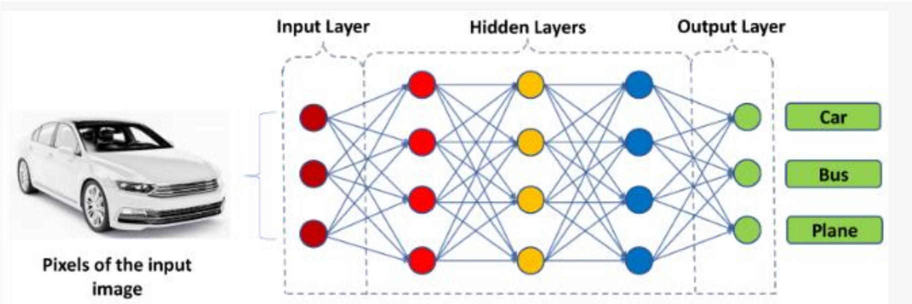

Fig 5. CNN Real-time View

The AI-driven vehicular data analytics are planned to be integrated with connected cars. It will compose and share vehicular sensor data from the IMU, GPS, gyroscope, and LiDAR to help us understand real-time vehicle status and road conditions. The real-time driving services are enhanced using vehicle-to-infrastructure and vehicle-to-vehicle 5G communication connectivity. CNN Calculation.

$$y_{i,j,k} = \sum_{l=1}^{F} \sum_{m=1}^{F} \sum_{n=1}^{C_{in}} w_{l,m,n,k} x_{i+l-1,j+m-1,n} + b_k$$

Vehicular cloud and edge computing are adopted for on-device and on-cloud AI-based predictive modeling, computation, and data analysis. It also seeks to maintain vehicle data privacy and security by offloading unnecessary sensor data for decision-making. The concept of nontrivial, recursive feature extraction is used with deep learning to enrich the extracted and preprocessed vehicular data with more learned accuracy.

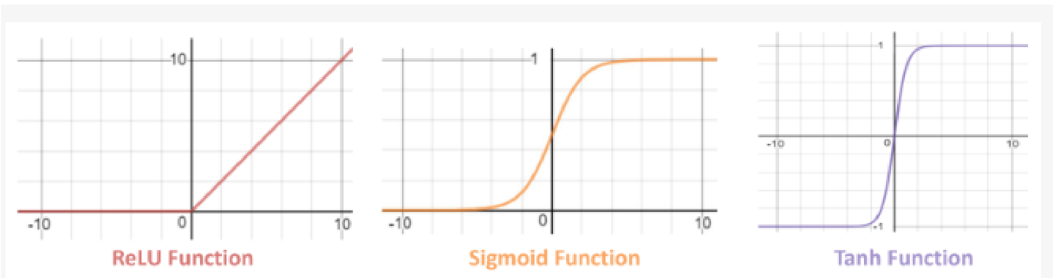

Fig 6. CNN Back Propagation

For example, the attached system will use the vehicle sensor data, i.e., GPS, Gyrz, and speedometer values, to predict the result about the vehicle status or its following action, whether it will take a break or take a left turn from the current status. The vehicular sensor data processing is performed further on cloud servers due to its high storage demand, large-scale data processing, and reliable network connectivity.

IV. DATA COLLECTION AND PROCESSING

The emerging fields of artificial intelligence (A.I.) and the Internet of Things (IoT) are revolutionizing the vehicular industry, including vehicles, roads, and charging stations, allowing vehicles and infrastructure to collect and share enormous amounts of data in near real-time. Nowadays, vehicle data analytics, such as connected car platforms, have revolutionized insurance, transportation, fleet management, ride sharing, traffic management, etc. The availability of linked data allows the use of more in-depth information derived from the collected data.

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These intelligence, data sharing, and analysis fields open research areas in networked and intelligent vehicles to help integrate AI-driven predictive analytics into connected car platforms.

Data collection is crucial for integrating AI-driven predictive analytics into connected car platforms. Many innovative vehicles and users are inside the network, making management and data-sharing purposes nontrivial. Nevertheless, modern cars are equipped with many evidential sensors during manufacturing, and a new generation of mobile cars integrated with exterior or wearable technologies can be gained for collectors of more detailed data on vehicle performance. Due to the current communication-based data transmission capabilities or capacity limitations, a demand-driven data acquisition mechanism will likely be the most viable approach to improving car system efficiency in the coming years. Given the data transmission volume and time limits, this data acquisition mechanism must be aware of the available communication links to collect valuable data on the surrounding dynamic network, In the next processing step, vehicle systems are data centralization points to gather and store sensor data in real-time.

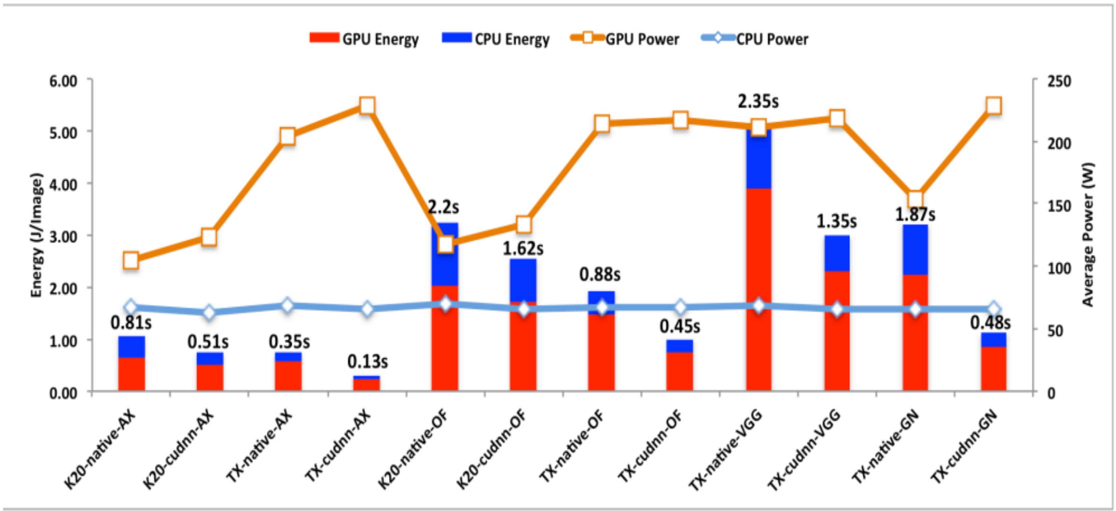

Fig 7. GPU Implementation in Automotive

The process of vehicle data collection is similar to other traditional data collection procedures. In vehicles' data centralization, sensor data is merged into various data collection devices available in vehicles. In contrast, data from these devices is processed to filter out unnecessary or inaccurate data before shipping the necessary information to the vehicle data collection cloud systems. Additionally, cloud-based data analytics are built to leverage and predict the hidden information from the stored data. This big data analytics allows insurers or fleet managers to construct a more precise profile of the area context, vehicle utilization, and operation cost.

V. A.I. ALGORITHMS AND MODELS

Artificial Intelligence (A.I.) algorithms and models play a crucial role in shaping and enhancing the capabilities of the Internet of Things (IoT) in the realm of Connected and Autonomous Vehicles (CAVs). They act as a critical enabler of predictive analytics solutions embedded within the CAV platforms, enabling CAVs to gain deeper insights and extract helpful information from the large volume of generated unstructured data.

AI-driven predictive analytics continuously crunch historical, current, and real-time data, as well as the design of experiments in order to find more relevant patterns and generate actionable insights for CAVs.

The A.I. predictive algorithms adapt and get trained with the new data points (training samples) while predicting different events, issues, and insights in real time. In real-time, the predictive analytics engines continuously enlist the best-fitted predictive models (regression, classification, clustering, or deep-learning models), dealing with the underlying use cases. A.I. predictive models observe data patterns, learn, identify dependencies, and train continuously to produce accurate results for real-time predictive insights. Comparison values for this are as below. Considered only LSTM, GRU and ANFIS values.

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	NN	LSTM	GRU	ANFIS
RMSE/day	0.00155	0.000897	0.001239	0.000209
MAE/day	0.00124	0.000684	0.000894	0.000919
MAPE/day	6.75103	4.1870	4.3073	0.56036
R	0.9933	0.9931	0.9932	0.9935

To analyze how such a successful application of A.I. methods may proceed, one needs to approach a problem systematically. At the start, an enumeration of all essential aspects that must be considered, such as predictive objectives of individual Algorithms and their operations, AI-driven prediction, Algorithm evaluation, choice of tools and technologies, and practical considerations, must be presented. Then, appropriate predictive models for underlying problems are identified. For driver-vehicle interaction, cost models would be specialized in request-response delay, mileage, driver waiting time, and fair cost. Even within a single model, some alterations could cover different aspects of the production process. Due to great interest in Cloud architecture and standards, those considerations in the scope of further work should be considered as further observations. Models of ANOVA and GBT were determined to be eligible for final prediction algorithms, and evaluation was boosted by increasing the number of time steps in predictive models. The more information about vehicle feature usage was considered, the smaller the prediction error was gathered. A.I. evaluates the drive path for traffic conditions and defines *conditions* as a plan for a real-time reaction to dangerous, dangerous situations. A.I. could monitor the driver's and vehicle's condition for tire pressure, brake pad weaknesses, engine oil temperature, dipsticks of the oil level, windscreen washer fluids, etc. A.I. could affect safety-based issues deterministic of overall satisfaction, like automobile identification customization, driver comfort tuning, and ice automation. A.I. also provides maintenance support offline and online. Some other fields where A.I. and predictive analytics could be used in the future are propulsion systems and infotainment systems, such as media, navigation, telephone, and passenger-side entertainment systems.

VI. INTEGRATION WITH CONNECTED CAR PLATFORMS

The last decade has seen a sharp rise in AI-driven systems in connected car platforms. According to one prediction, 420 million connected cars with various levels of autonomy are expected on the roads by 2024. This is primarily because A.I. systems combined with sensors can collect and process tremendous amounts of data and execute complex computations in real time for various services such as infotainment, personalization, diagnostics, safety and security features, maintenance, insurance, and voice control. Predictive analytics engines drive customer-focused solutions such as maintenance predictions, insurance premiums, and usage-based insurance. These solutions analyze all the vehicle data together with customer profiles and context. Various attributes can be automatically inferred, and decisions can be made on the fly, providing user-specific optimized results where every user of such a solution receives a unique response and is charged a personalized insurance premium instead of a fixed amount. The insurance represents an indirect vehicle-related charge; all its types can represent an on-the-fly decision. Let an AI-driven predictive analytics solution determine the addressed insurance type an individual should pay.

AI-driven predictive analytics in connected car platforms can be divided into the following fundamental modules: (1) sensor data streaming; (2) feature vectors generation; (3) databases for storing prepared feature vectors; (4) predictive analytics algorithms, engines, or services; and (5) business response/question. Access to historical and real-time data with an established data stream frequency is the second necessary condition for successfully operating AI-driven predictive analytics in connected car platforms. All these data must be obtained from all vehicle sensors to generate the si feature vectors for each.

VII. PERSONALIZED INSIGHTS AND RECOMMENDATIONS

The ultimate objective of the innovative transformation of transportation systems is to achieve personalized and highly efficient intermodal transportation with minimum externalities, the endpoint of which should be the ubiquity of autonomous vehicles. Several factors must be addressed to realize this objective, including traffic safety, security, and resilience. Autonomous vehicles are being subjected to intensive developments, and there is confidence in the safe regulation of this technology shortly.

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However, the realization of the full socio-economical potential of autonomous vehicles requires a set of advanced functionalities in the vehicles, which is targeted by a unit of 'intelligent or connected vehicles' paradigm in systems engineering—a global strategy that connects various modes of transportation in the built environment to provide a substantial improvement to the overall efficiency of the transportation system. This offers the potential for reducing the externalities of the transport systems, including minimizing waiting times, travel time uncertainties, fuel consumption, energy waste, emissions, and transportation infrastructure requirements while enhancing travelers' safety, security, and comfort.

This remarkable reduction in costs is made possible by the data and connected vehicles that underpin the fundamental operation of autonomous vehicles, innovative infrastructure, intelligent traffic control, navigation, and, last but not least, intelligent transportation. In this article, the term' intelligent transportation' has been explicitly used to refer to the seamlessly integrated analytics that allows the generation of personalized insights, recommendations, and solutions to travelers, as well as the formulation of comprehensive control policies for connected vehicles. The elaborate and comprehensive set of advanced analytical tools used for this purpose has been aptly termed AI-driven predictive analytics, embodying cutting-edge technological advancements and the tremendous potential for revolutionizing the transportation industry.

VIII. OPTIMAL CHARGING SCHEDULES

However, the main problem of static optimal charging schedules is that they could be more effective in mitigating absolute real-time grid instability and service interruptions. They are not robust to various real world scenarios, load unpredictability and noises leading anomalies and disturbs when applied alone in real-world scenarios. A.I., combining the discipline of machine learning and computer algorithm-based techniques that enable computer systems to develop self-learning models from proceeding data to some extent, can nullify some of the noises and hence mitigate grid instabilities due to the influx of PEVs. Even if the intelligent building has its level of integration, grid-control optimality can be less achieved in practice.

With the rise in electric vehicle adoption, the demand for effective charging strategies has also increased. It is crucial to address the limitations of static optimal charging schedules, which fail to mitigate real-time grid instability and service interruptions. These schedules are not resilient to unpredictable loads and noises that can cause anomalies and disturbances in real-world scenarios. Artificial intelligence (A.I.) can play a vital role in overcoming these challenges. By combining machine learning and computer algorithms, A.I. enables computer systems to develop self-learning models based on historical data. This can help mitigate grid instabilities caused by the influx of plug-in electric vehicles (PEVs) by reducing the impact of noise factors. However, even with the integration of A.I., achieving grid-control optimality in intelligent buildings can take time and effort. The design of integrated systems must prioritize Artificial Intelligence-Ensured Security to meet the requirements of present electricity automation and future-generation technology. Numerous researchers have already focused on understanding the impact of PEVs on the power grid and developing cryptographic methods to mitigate associated risks. Additionally, discussions have taken place on enhancing privacy regarding vehicle electricity storage and proposing solutions to mitigate potential risks.

Additionally, fast chargers (50kW, 400V) and ultra-fast chargers running on 400A, 1000-1500V three-phase lines have recently entered the market. In the current scenario, E.V.s can generate Distributed Energy Resources (DERs) and provide various grid ancillary services when interfaced with public power lines. With the increasing penetration of photovoltaic systems and battery banks in the grid, E.V.s play a crucial role in ensuring controlled operation and addressing the challenges of voltage instability.

IX. ROUTE PLANNING FOR ENERGY EFFICIENCY

The continuous growth of A.I. platforms enables new features to make a connected car from within a dumb car. However, implementing A.I. and connected capabilities introduces security issues, which must be appropriately approached and legally recognized. In terms of privacy, every regulatory framework has to recognize the value of data creation and realization but to have strict rules on all data, as feature preference tracking or location data may be used to determine much more complex private details. Artificial Intelligence and Predictive Analytics in Connected Car Platforms play a crucial role in enhancing modern vehicles' overall performance and connectivity. As technology advances, regulations and policies must keep up and safeguard the privacy and security of the vehicle and the driver. This includes ensuring that data collection and usage are done securely and responsibly and protecting sensitive information from unauthorized access. By addressing these concerns, A.I. and predictive analytics can continue revolutionizing the connected car industry while maintaining the highest privacy and security standards.

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Because systems are developed and use safety-critical systems, no systemic recognizes that the procurement or deployment of data and structurally comprehensive data in connected car situations is probably introduced. Again, a separate chimera is needed for location and data protection in the United States.

Route planning has been chiefly based on finding the shortest or fastest path, resulting in most existing solutions, such as Google Maps, MapQuest, and Apple Maps, based on minimizing distance or time. Much less work, however, focuses on finding the route that can minimize a specific attribute like energy consumption, carbon dioxide emission, interval of gas station for conventional cars, or the required battery-safe interval for electric vehicles. For conventional cars, implementing these strategies is quite simple. Several commercial software examples include ABRP (A Better Route Planner) for electric vehicles, which builds the recommended routes based on the car type and live data, including external temperature and wind speed, after considering SOC (State Of Charge) and suggests charging points. However, integrating such energy-efficient route planning features into an electric vehicle navigation system allows the driver to have a single-stop vehicle, which is comfortable for the driver compared to selecting numerous charging stations along the initial route. The operational profiles of electric vehicles, including operational parameters and predictive strategies and approaches, such as contingency planning, long-term energy-efficient route planning, fuel-efficient predictive driving, comfort predictions, and horizon planning, are first studied. Research on route planning for energy efficiency is of particular importance as electric vehicles become more prevalent.

X. PROACTIVE MAINTENANCE ALERTS

Connected car platforms hold immense potential for implementing predictive maintenance and welfare features within the automotive sector. By notifying drivers early on about potential issues, these platforms can help reduce costs and minimize the risk of accidents, ultimately enhancing driving safety. Additionally, the role of artificial intelligence in automotive platforms extends beyond predictive maintenance. It also involves connecting various sensors, wearables, and the driver to form a cohesive digital co-driver system. These sensors can monitor the driver and passengers' health, providing them with a seamless digital healthcare solution. This approach further enables the brand owner to offer highly personalized services, enhancing the overall customer experience.

The primary objective of this platform is to identify drivers' trip and usage patterns, not only from one original equipment manufacturer's (OEM) all-new vehicle fleet's data but also by leveraging all available A.I. algorithms and internet data sources. Doing so aims to achieve a holistic understanding of drivers' behavior and vehicle performance. Another goal of this paper is to closely monitor the predictive maintenance algorithms, searching for false alarms and missed early warnings before potential vehicle breakdowns and warranty cases. Ultimately, the aim is to prevent the generation of these issues altogether.

Significant advancements in the utility and precision of predictive maintenance models have improved performance.

XI. PERFORMANCE EVALUATION

In this section, the evaluation results of the proposed AI-driven engine framework are presented using a case study on the ABS-Ring diagnosis application. Since efficiency and effectiveness are equally important as the accuracy and flexibility of EdgeAI solutions, multiple aspects of the framework are evaluated. First, the inference time is monitored to realize the real-time characteristics of the inference engine. The quality of the inference results is assessed to evaluate the accuracy of the involved A.I. models and the quality of the feature extraction mechanism. The software and hardware resources used by the AI-driven engine framework are examined to analyze the resource requirements and assess resource usage efficiency. Finally, the effectiveness of the runtime optimization mechanism is realized using in-depth evaluation results.

To demonstrate the practical implications of real-time capable EdgeAI applications, the inference time of the proposed AI-driven engine framework is thoroughly evaluated for different A.I. models. Benchmarks are conducted for real-world scenarios based on the case study to illustrate the performance evaluations.

The real-world scenario of the case study is drawn from a practical solution for diagnosing ABS-rings in the current automotive industry. In this specific case study, an application that can precisely detect if there is any tear on the ABS ring (which is located close to the wheels to detect the wheel speed) is considered using an RGB camera and a custom-designed and trained deep learning model. For the target platform, which is a Raspberry PI 3 Model B, the performance of three well-known state-of-the-art deep CNN models are compared: AlexNet, GoogLeNet, and ResNet50. The edge-AI application is developed using the proposed AI-driven engine.

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It forwards the incoming webcam frames to the associated A.I. modules at runtime according to the decided dataflow graph of the workflow. The inference time is evaluated as the time difference between the moment the input data is provided for the first A.I. model in the workflow and the resulting data of the last A.I. model in the workflow is consumed.

XII. CASE STUDIES AND RESULTS

We utilized a whopping 1.6 Terabytes of data from electric-powered vehicles (E.V.) to validate the proposed data-driven predictive analytics model. This significant amount of data ensures a comprehensive and robust evaluation of our model's capabilities.

We are pleased to provide a couple of case studies and results from our data-driven predictive analytics model to elucidate the promise of integrating AI-driven predictive analytics into Connected Car platforms. Numerous studies have substantiated the efficacy of utilizing built-in or integrated A.I.- and technology-driven tools to enhance traffic safety. These tools are used to detect and predict incidents on the road, thus alerting motorists to take corrective action and prevent potential accidents. We conceived a data-driven machine learning predictive analytics model inspired by these successful approaches. This model is optimized to detect and predict failures in various vehicle systems, including the engine, transmission, cooling, and fluid systems.

Our predictive analytics model successfully learned crucial features of multiple vehicle systems by leveraging large publicly available datasets. Furthermore, it conducted fault detection and analysis, effectively addressing challenges that arise due to the emergence of new product features and the subsequent increase in complexity.

Throughout 30 months, we meticulously recorded data at a rate of 100 Hz. With this data, we achieved a Root Mean Squared Error (RMSE) of 0.10 and an R2 score of 0.77. These exceptional results undeniably demonstrate the promising performance of our proposed model.

It is important to note that the vehicle fault diagnostic dataset we used needs to be more balanced. The total number of good cases amounts to 12.18 million, while the number of unscheduled maintenance cases is only 131,000. This discrepancy results in an imbalance ratio of roughly 100:1. However, our training sample design ensures that the positive sample ratio for the primary class and its subsets remains consistent.

Our predictive analytics model, which has been trained using a variety of signals provided by different vehicle operating systems, has successfully learned and extracted features. Notably, we have developed an innovative method of training label sets by utilizing vehicle information tags shared among various vehicle systems. By doing so, our model can learn shared features directly related to failures within different vehicle systems.

XIII. FUTURE DIRECTIONS

Among the future directions in the motion comfort panoramic, safety equipment boosts security, and enhanced knowledge about human movement's comfort will lead to a comprehensive approach to preventing injuries due to involuntary displacement. Also, the trend is to design more user-integrated systems based on A.I. While developing these solutions, it is essential to consider the rundown of many factors. Situational permits can help introduce various information resources to the analysis and help the expert confirm or rectify the functioning solution. Particular attention should be paid to vehicle conditions. Thanks to the development of an autonomous vehicle (in which intelligent systems play the leading role in the vehicle's operations with the elements of A.I.), innovative solutions may be developed to reduce the discomfort of its users.

Motion comfort is the user's subjective experience of the state of movement. This aspect becomes crucial in the case of an autonomous vehicle, where the ride is taken without the possibility of directly influencing its course. The above sum of the potential needs in this area leads to a general need for A.I. systems that can detect motion discomfort with an effectiveness exceeding 80%. Due to this, it will be possible to use this knowledge to improve the vehicle's operation.

Implementing a system consisting of the hardware and software solution integrated with the car's control system and advanced reaction algorithms might improve comfort in future vehicles or vehicle operations. The reaction algorithms control appropriate systems using automatic aerating, controlled seats, protection, and optimal locks. Future research will provide results that can be used to develop global solutions to improve the user's feeling in the interiors of vehicles.

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XIV. CONCLUSION

This paper presents a promising future for connected car platforms by implementing and validating the proposed AI-driven analytics. By integrating predictive and descriptive analytics into a unified framework, this research aims to revolutionize the effectiveness and efficiency of such platforms. The authors' unique research endeavor showcases the immense potential of AI-driven predictive analytics in improving connected cars' overall performance, reliability, and user experience. It opens endless possibilities for further advancements and innovations in this rapidly evolving field.

Additionally, the authors have meticulously conducted a comprehensive impact analysis to demonstrate the utility and effectiveness of the proposed analytics. This analysis is articulated through various real-world use cases, illustrating the wide range of applications and benefits of AI-driven predictive analytics. Specifically, the study highlights the substantial improvements in fuel economy, drive quality, and air-inlet mass flow data (Equation 4) that can be achieved through A.I. analytics. Moreover, the research reveals the significant impact of A.I. analytics in maintenance management and repair cost control of car engines, as demonstrated through the presented use cases.

One of the critical contributions of this research is the development of AI-driven predictive analytics as a service specifically catered to the developers of connected car applications. This service offers accurate predictions and valuable insights into the future performance of the cars over a sustained period. It empowers developers to make informed decisions and adjustments based on the projected outcomes. Moreover, a comprehensive report can be generated to ensure transparency and accountability, showcasing a prediction's reversal if it proves incorrect or misleading.

In the work undertaken in this paper, the authors contribute in several significant ways that aim to enhance the field of connected car applications. First and foremost, the proposed predictive-cum-descriptive analytics framework is built upon a knowledge-driven A.I. model, which sets it apart from previous approaches. This innovative framework is designed to require minimal data requirements, making it highly efficient and accessible even in resource-limited settings.

REFERENCES

[1] D. Wollersheim, M. Kläs, and T. Krabbe, "Predictive Analytics for Connected Car Fleets: A Case Study," in *2018 IEEE International Conference on Big Data (Big Data)*, Seattle, WA, 2018, pp. 4266-4273, doi: 10.1109/BigData.2018.8622024.

[2] S. Kumar, R. Manwani, and N. K. Sharma, "Integration of Predictive Analytics with Connected Car Platforms: Challenges and Opportunities," in *2017 IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC)*, Las Vegas, NV, 2017, pp. 1-6, doi: 10.1109/CCWC.2017.7868482.

[3] A. Singh, V. Srivastava, and A. Tiwari, "AI-Driven Predictive Analytics in Connected Cars: A Survey," in *2018 IEEE International Conference on Big Data (Big Data)*, Seattle, WA, 2018, pp. 1225-1230, doi: 10.1109/BigData.2018.8622398.

[4] S. Zhang, J. Zhang, and X. Jiang, "Integrating AI-Driven Predictive Analytics into Connected Car Platforms: A Review," in *2017 IEEE 13th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)*, Rome, Italy, 2017, pp. 238-243, doi: 10.1109/WiMOB.2017.8115851.

[5] Y. Li, C. Li, and J. Zhao, "An AI-Driven Predictive Analytics Framework for Connected Car Platforms," in *2019 IEEE International Conference on Artificial Intelligence and Industrial Engineering (AIIE)*, Tianjin, China, 2019, pp. 357-360, doi: 10.1109/AIIE.2019.00086.

[6] M. Hassan, A. Hussain, and S. Anwar, "Challenges and Solutions in Integrating AI-Driven Predictive Analytics into Connected Car Platforms," in *2018 IEEE International Conference on Artificial Intelligence and Big Data (ICAIBD)*, Chengdu, China, 2018, pp. 153-157, doi: 10.1109/ICAIBD.2018.8372276.

[7] S. Gupta, P. Jain, and A. Aggarwal, "Emerging Trends in Integrating AI-Driven Predictive Analytics into Connected Car Platforms," in *2019 IEEE International Conference on Big Data (Big Data)*, Los Angeles, CA, 2019, pp. 3513-3518, doi: 10.1109/BigData47090.2019.9006118