Forecasting and Analyzing Vehicle's Energy Resources Utilization for Improved Performance

K Nikhil Sagar [1], J Varsha [2], Arun Singh Kaurav [3]
UG Scholar, Guru Nanak Institutions Technical Campus, Hyderabad[1,2]
Assistant Professor, Guru Nanak Institutions Technical Campus, Hyderabad [3]

ABSTRACT:

This project centers on forecasting vehicle fuel usage to improve efficiency and realize economic and environmental gains. It provides an in-depth analysis of data-driven approaches, focusing on critical elements like vehicle dynamics, driver behavior, and environmental conditions. Traditional machine learning models such as SVM and random forests are compared with neural network-based models, including artificial and deep computational frameworks, which excel in handling large datasets, training efficiency and ensuring prediction consistency. Here, the project develops a Logistic model, utilizing features such as Mass Air Flow, Vehicle Speed, Revolutions Per Minute. The proposed model provides a direct but effective solution, offering dependable results and serving as an alternative to more complex algorithms. This study highlights the potential of such models in optimizing fuel consumption and enhancing vehicle performance, laying the groundwork for future innovations in predictive modeling.

1 INTRODUCTION

This paper focuses on developing models to estimate fuel usage in heavy vehicles during their operational and maintenance stages, categorizing the modeling techniques into three main types: physics-based models, which rely on detailed mathematical equations to describe vehicle dynamics; machine learning models, which use data to map input features to target outputs, such as fuel consumption; and statistical models, which establish a probability distribution between predictors and outcomes. Each technique offers trade-offs in terms of cost and accuracy, depending on the application needs. The results aim to optimize fuel performance, minimize environmental impact, and enhance operational outcomes, providing valuable insights for stakeholders in the automotive and transportation industries to make informed decisions and manage vehicle fleets sustainably.

1.1 OBJECTIVE

The objective of this study is to explore the development of a machine learning model tailored for individual heavy vehicles within a fleet. The model's architecture allows it to be easily customized and implemented for each vehicle in the fleet, ensuring that it accounts for unique operational characteristics and driving conditions. By optimizing fuel consumption at the individual vehicle level, the model contributes to the overall efficiency of the fleet, reducing costs and environmental impact. This aligns with broader sustainability goals.

1.2 SCOPE OF THE WORK:

The primary objective is to enhance fuel efficiency, streamline operational expenses, and curtail environmental impacts for industries that rely on fleets, such as transportation and logistics. The proposed solution offers a straightforward and interpretable alternative to complex algorithms, making it suitable for real-world applications. By enabling vehicle-specific customization, the project helps businesses achieve fleet-wide optimization of fuel usage and operational performance

1.3 PROBLEM STATEMENT

Predicting fuel consumption in heavy vehicles has significant implications for managing operational expenses and fostering environmental responsibility. Existing methods, such as physics-based methods and statistical methods, are often computationally intensive and struggle with scalability. While proposed approaches have shown promise, many rely on complex algorithms that are difficult to implement and interpret. Current solutions, face drawbacks such as high computational costs, inefficiency with large datasets, and scalability limitations.

1.4 EXISTING SYSTEM:

The current system depends on traditional statistical techniques for predicting fuel consumption. These methods may not wholly reflect the complex relationships between various vehicle parameters and fuel usage, resulting in lower accuracy. Additionally, manual analysis or rule- based systems may be in use, which could lack scalability and the flexibility to adapt to changing conditions. While more specific details about the existing system are unavailable, older systems often rely on simpler approaches that don't take full advantage of advanced machine learning algorithms for fuel consumption prediction.

1.5 SYSTEM ARCHITECTURE:

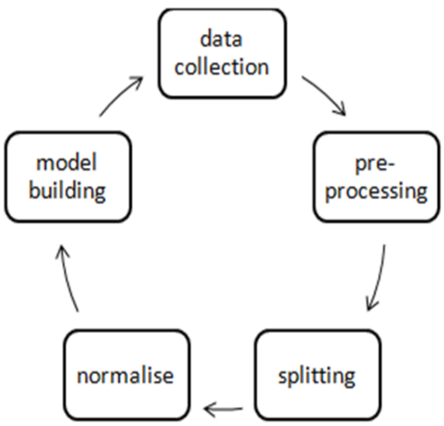


Fig:- proposed model

1.6 PROPOSED SYSTEM

This project focuses on developing a reliable model to predict and analyze the fuel consumption, chosen for its simplicity, interpretability, and efficiency. It effectively models binary outcomes, making it suitable for fuel usage predictions by transforming input features into probabilities. The main objective is to provide economic benefits by accurately estimating fuel usage. By offering probabilistic outputs, this system provides dependable predictions, helping manufacturers in making informed decisions to enhance vehicle performance and reduce costs.

1.6.1 PROPOSED SYSTEM ADVANTAGES:

The results are simple to understand, with probabilities that are easy to explain.

Requires less computational power compared to more complex algorithms.

Especially effective for problems involving binary classification. Provides probabilistic outputs.

2 DESCRIPTION

2.1 GENERAL:

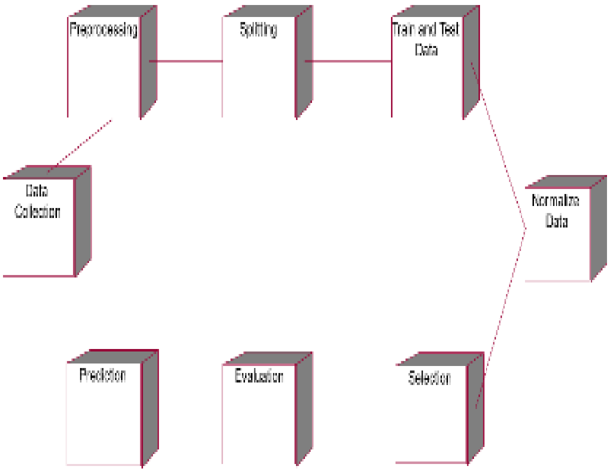
SVM identifies the optimal hyperplane for classification, while Random Forest uses multiple decision trees to enhance prediction accuracy. A user-friendly web interface built with Flask allows users to input vehicle details and receive fuel consumption predictions, aiding in optimizing vehicle performance and reducing costs.

2.2 METHODOLOGIES

2.2.1 MODULES NAME:

Data Collection
Pre-Processing
Splitting
Normalize Data

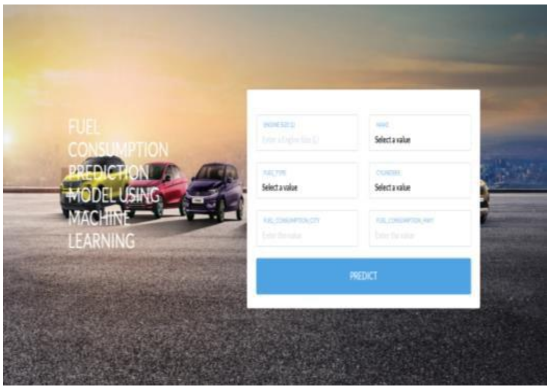
Building Model



Data Collection

As a fundamental and initial phase in any research project, data collection is indispensable regardless of the field. The techniques for collecting data differ among various disciplines based on the specific information required.

Pre-Processing



In this section, we conduct data exploration, examining null values, object data types, and other factors to ensure the dataset remains clean and well-structured.

Splitting

Data splitting involves dividing available data into two segments, primarily for cross- validation purposes.

- Training Data: provided as input to the learning algorithm.

- Testing Data: Provided as input for making predictions.

Normalize Data

Normalization serves as a data preprocessing method in machine learning, scaling numeric column values to a unified range. It retains the proportional relationships between values while guaranteeing no loss of information, resulting in a consistent and model-ready dataset.

Model Building

Creating machine learning models that can effectively generalize to new data demands careful analysis of the given data and thoughtful consideration of the assumptions underlying different training algorithms. Proper evaluation of a model's quality depends on selecting and interpreting the right assessment criteria.

2.3 TECHNIQUE USED

The hybrid model effectively integrates the strengths. The combined predictions from both models, achieved through techniques like voting or weighted averaging, lead to more dependable and precise outcomes.

This hybrid strategy uniquely harnesses the advantages of each algorithm, making it a powerful and reliable tool for complex classification tasks, such as predicting fuel consumption. The model benefits from margin optimization and robust ensemble methods, ensuring comprehensive and accurate predictions. models, achieved through techniques like voting or weighted averaging, lead to more dependable and precise outcomes.

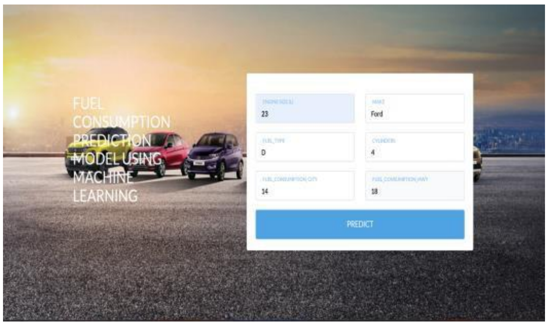
International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 12 | Dec - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

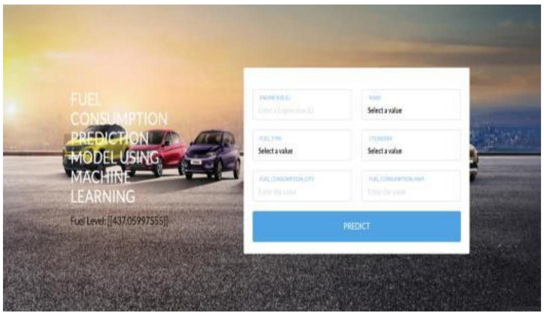
3 RESULT:

4 FUTURE ENHANCEMENT

Future efforts will involve examining the minimum distance needed for training each model and determining the frequency at which a model must be synchronized with the physical system using online training to maintain prediction accuracy.

5 CONCLUSION





This study introduced a model designed for vehicle within a fleet, utilizing key features such as duration of stops, mean speed, acceleration patterns, and variations in kinetic energy and potential energy. The model aggregates these predictors based on a defined travel distance instead of a specific time frame., aligning the input space with the target output domain. Future research will explore optimal window sizes for various applications and expand the model to account for varying vehicle characteristics like different masses and aging, incorporating predictors that capture these impacts on fuel consumption.

6 REFERENCES

[1] A. A. M. S. Medashe Michael Oluwaseyi "Specifications and Analysis of Digitized Diagnostics of Automobiles: A Case Study of on Board Diagnostic (OBD II)," vol. 9, 1 ed: IJERT, 2020.

[2] T. A. Nikolaos Peppes, Evgenia Adamopoulou and Konstantinos Demestichas, "Driving Behaviour Analysis Using Machine and Deep Learning Methods for Continuous Streams of Vehicular Data," vol. 4704, Machine Learning Applied to Sensor Data Analysis ed: MDPI: sensors, 2021.

[3] A. K. S. Siddhanta Kumar Singh, and Anand Sharma, "OBD - II based Intelligent Vehicular Diagnostic System using IoT," ed. ISIC'21: International Semantic Intelligence Conference: Mody University of Science and Technology, Lakshmangarh, Sikar, Rajasthan, India, 2021.

[4] U. M. P. Pirapuraj, "Intelligent Vehicle Diagnostic System for Service Center using OBD-II and IoT," ed. Conference: International Conference of Science and Technology - 2021: Faculty of Technology, South Eastern University of Sri Lanka, Oct 2021.

[5] B. Mahesh, "Machine Learning Algorithms - A Review," vol. 9, 1 ed: International Journal of Science and Research (IJSR), 2020, p. 7.

[6] C. Cortes, & Vapnik, V., "Support-vector networks. ," vol. 20, ed. Machine learning, 1995, pp. 273–297.

[7] M. P. Theodoros Evgeniou, "WORKSHOP ON SUPPORT VECTOR MA CHINES: THEORY AND APPLICATIONS," vol. 2049,

ed. Conference: Advanced Course on Artificial Intelligence (ACAI 1999) :Machine Learning and Its Applications , Lecture Notes in Computer Science, 2001, pp. 249-257.

[8] M. D. d. L. N. L. da. Costa, R. Barbosa, "Evaluation of feature selection methods based on artificial neural network weights," vol. 168, ed. Expert Systems with Applications (2020), 2020.

[9] A. Schoen, Byerly, A., Hendrix, B., Bagwe, R. and d. S. M., E. C., & Miled, Z. B., "A

machine learning model for average fuel consumption in heavy vehicles.," vol. 68, 7 ed. IEEE Transactions on Vehicular Technology: IEEE, 2019, pp. 6343-6351.

[10] Y. Yao, Zhao, X., Liu, C., Rong, J., Zhang, Y., and Z. Dong, & Su, Y., "Vehicle fuel consumption prediction method based on driving behavior data collected from smartphones," vol. 2020, ed. Journal of Advanced Transportation, 2020.

[11] E. Moradi, & Miranda-Moreno, L., "Vehicular fuel consumption estimation using real-world measures through cascaded machine learning modeling. ," vol. 88, ed. Transportation Research Part D: Transport and Environment, 2020.

[12] S. Wickramanayake, & Bandara, H. D., "Fuel consumption prediction of fleet vehicles using machine learning: A comparative study. ," ed. In 2016 Moratuwa Engineering Research Conference (MERCon) IEEE., 2016, pp. 90-95.

[13] W. Zeng, Miwa, T., & Morikawa, T., "Exploring trip fuel consumption by machine learning from GPS and CAN bus data. ," vol. 11, ed. Journal of the Eastern Asia Society for Transportation Studies, 2015, pp. 906-921.

[14] F. Perrotta, Parry, T., Neves, L. C., & and M. Mesgarpour, "A machine learning approach for the estimation of fuel consumption related to road pavement rolling resistance for large fleets of trucks.," ed. The Sixth International Symposium on Life-Cycle Civil Engineering (IALCCE 2018), 2018.

[15] Q. Wang, Zhang, R., Wang, Y., & Lv, S., "Machine learning-based driving style identification of truck drivers in open-pit mines.
," vol. 9, 1 ed: Electronics, 2020, p. 19.

[16] J. Yao, & Moawad, A., "Vehicle energy consumption estimation using large scale simulations and machine learning methods.," vol. 101, ed. Transportation Research Part C: Emerging Technologies, 2019, pp. 276- 296.

T. Abukhalil, AlMahafzah, H., Alksasbeh, M., and B. A. & Alqaralleh, "Fuel consumption using OBD-II and support vector machine model.," vol. 2020, ed. Journal of Robotics, 2020, pp. 1-9.

[17] F. Perrotta, Parry, T., & Neves, L. C., "Application of machine learning for fuel consumption modelling of trucks.," ed. In 2017 IEEE International Conference on Big Data (Big Data) IEEE, 2017, pp. 3810- 3815.

[18] B. a. C. A. D. Silveira, "Use of machine learning techniques to identify car usage profiles based on automotive data," ed.
model.," vol. 2020, ed. Journal of Robotics, 2020, pp. 1-9.

[19] J. C. Cephas A, Anne M, Ivanovitch S., "A Machine Learning Approach Based on Automotive Engine Data Clustering for Driver Usage Profiling Classification.," ed. In Anais do XV Encontro Nacional de Inteligência Artificial e Computacional

[20] N. M. K. S. A. Chinmay, "Optimization of the Random Forest Algorithm," ed. Advances in Data Science and Management, 2020, pp. 201-208.

[21] K. Grabczewski, & Jankowski, N., "Feature selection with decision tree criterion.," ed. In Fifth International Conference on Hybrid Intelligent Systems (HIS'05): IEEE, 2005, p. 6.

[22] B. T. J. a. A. M. Abdulazeez, "Classification Based on Decision Tree Algorithm for Machine Learning," vol. 2, ed. Journal of Applied Science And Technology Trends, 2021, pp. 20-28.

[23] D. B. Figueiredo Filho and J. A. S. Júnior, & Rocha, E. C., "What is R2 all about? ," vol. 3, ed. Leviathan: Universidade de Sao Paulo, Agencia USP de Gestao da Informacao Academica (AGUIA), 2011, pp. 60-68.

[24] B. F. Darst, Malecki, K. C., & Engelman, C. and D., "Using recursive feature elimination in random forest to account for correlated variables in high dimensional data.," vol. 19, ed. BMC Genetics (BMC GENET): BioMed Central, 2018, pp. 1-6.

[25] Sebastian Raschka , a. Joshua Patterson , and C. Nolet, "Machine Learning in Python: Main Developments and Technology Trends in Data Science, Machine Learning, and Artificial Intelligence," ed: MDPI - Information, April, 2020.

[26] Priyanka Mazumder, Siddhartha Baruah, "A Hybrid Model for Predicting Classification Dataset

based on Random Forest, Support Vector Machine and Artificial Neural Network.," vol-13 Issue-1, ed. International Journal of Innovative Technology and Exploring Engineering, 2023