IT4010 – Research Project - 2024

Topic Assessment Form

Project ID : R25 - 034

1. Topic (12 words max)

Autonomous Driving: Predicting Driver Behavior and Vehicle Maintenance Using Simple Data

2. Research group the project belongs to

TIM - Technology Integration and Management

3. Specialization of the project belongs to

Information Technology (IT)

4. If a continuation of a previous project:

Project ID	
Year	

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

The automotive industry has experienced significant advancements due to artificial intelligence (AI) and machine learning (ML), focusing primarily on autonomous driving and vehicle safety. However, the potential of leveraging basic on-board data to predict driver behavior and vehicle maintenance needs remains underexplored. Factors such as inconsistent driving patterns, lack of personalized maintenance schedules, and limited understanding of environmental impacts on driving pose challenges to scalability and feasibility.

Existing systems often rely on complex diagnostic tools and proprietary data that exclude non-connected or older vehicles. Additionally, weather conditions and human driving behaviors significantly influence safety and fuel efficiency, but current solutions lack personalized and scalable approaches to address these aspects comprehensively.

This research aims to use simple, non-invasive data sources, such as mobile phone sensors, basic vehicle sensors, and publicly available environmental data, to create machine learning models. Data will be gathered through accessible methods, including telematics apps that record driving patterns, public meteorological databases for weather data, and historical maintenance logs. The goal is to deliver cost-effective and scalable solutions that enhance safety, maintenance efficiency, and fuel economy for a wide user base.

References:

Doshi, A., & Trivedi, M. M. (2012). Attention estimation by simultaneous observation of driver and driving context. IEEE Transactions on Intelligent Transportation Systems, 12(4), 877–889.

Al-Dulaimi, A. A., et al. (2020). Predictive maintenance in the automotive industry using machine learning. IEEE Access, 8, 83995–84005.

Stern, R., et al. (2018). Data-driven weather impact analysis on driving performance. Transportation Research Part C: Emerging Technologies, 94, 1–16.
Examines how weather affects human driving behavior.

Zhang, Y., et al. (2020). Fuel consumption prediction based on driving behavior and vehicle status. Transportation Research Part D: Transport and Environment, 80, 102251.
Discusses fuel efficiency modeling using vehicle and driving data.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

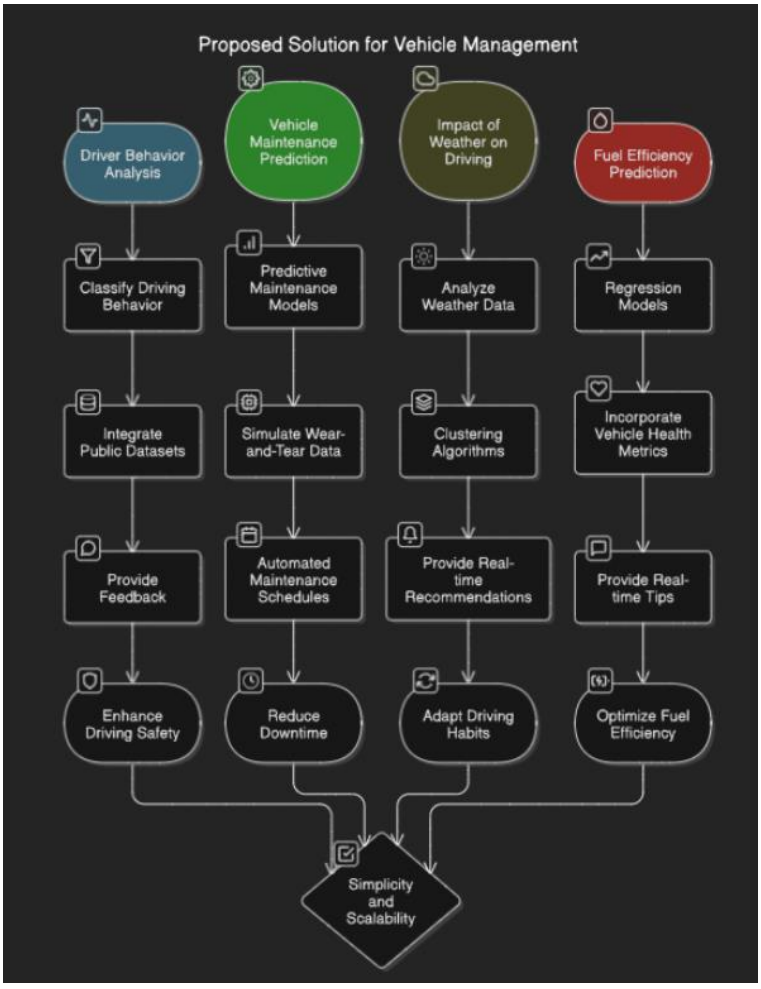
The proposed solution consists of four components:

1. **Driver Behavior Analysis**:
    - Machine learning models classify driving behavior into categories (e.g., aggressive, cautious, moderate) using accelerometer and GPS data.
    - Public driving datasets are integrated to enrich analysis and improve model accuracy.
    - Feedback mechanisms provide real-time suggestions to enhance driving safety and efficiency.
2. **Vehicle Maintenance Prediction**:
    - Predictive maintenance models utilize historical logs, mileage, and part replacement histories.
    - Simulated wear-and-tear data complements real-world datasets to improve predictions.
    - Automated maintenance schedules reduce downtime and costs.

connected and non-connected vehicles.

3. **Impact of Weather on Driving**:
    - Weather data is analyzed alongside driving patterns to identify risk factors.
    - Clustering algorithms find correlations between weather and driving behaviors.
    - Real-time recommendations are provided to adapt driving habits to current conditions.
4. **Fuel Efficiency Prediction**:
    - Regression models predict fuel consumption based on speed, braking, and environmental factors.
    - Vehicle health metrics are incorporated to refine predictions.
    - Real-time, personalized tips optimize fuel efficiency through a user-friendly interface.

Each component emphasizes simplicity and scalability, making it applicable for both connected and non-connected vehicles.



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max):

Specialized Expertise:

1. **Machine Learning:**
    - In-depth knowledge of supervised learning algorithms, such as decision trees, support vector machines (SVM), and neural networks, to model driver behavior and vehicle maintenance patterns.
    - Experience with regression techniques and time-series forecasting for predicting fuel efficiency and part lifespans.
    - Familiarity with clustering algorithms for analyzing weather data and its impact on driving patterns.
2. **Data Analytics:**
    - Proficiency in data preprocessing techniques, including cleansing, normalization, and feature extraction, to ensure high-quality input for machine learning models.
    - Expertise in integrating multi-source datasets, including real-time sensor data, historical logs, and public datasets.
    - Skills in creating cloud-based solutions to manage and analyze large volumes of data efficiently.
3. **Automotive Systems:**
    - Understanding vehicle diagnostics, including common failure modes and wear-and-tear patterns.
    - Familiarity with automotive sensors and their limitations, ensuring models are optimized for real-world conditions.
    - Knowledge of fuel consumption dynamics and environmental impacts on vehicle performance.

Data Requirements:

1. **Behavioral Data:**
    - **Source:** Mobile apps, telematics platforms, and public driving datasets.
    - **Parameters:** Acceleration, braking intensity, speed patterns, route histories, and vehicle positioning (via GPS).
2. **Environmental Data:**
    - **Source:** Real-time meteorological APIs and road condition databases.
    - **Parameters:** Weather types (e.g., rain, snow, fog), temperature, time of day, and road surface conditions.
3. **Vehicle Maintenance Data:**
    - **Source:** Historical maintenance logs, manufacturer-provided wear-and-tear estimates, and user-recorded part replacement histories.
    - **Parameters:** Vehicle mileage, part failure rates, replacement timelines, and associated costs.
4. **Integration Needs:**
    - **Storage:** Cloud platforms for centralized data storage and processing.
    - **APIs:** Connect data sources to machine learning models, enabling real-time updates and analysis.
    - **Validation:** Cross-verification with automotive experts and field trials to ensure data accuracy and model reliability.

8. Objectives and Novelty

<table>
<tr><td colspan="4">Main Objective

To develop a machine learning-driven system that integrates non-invasive data sources to predict driver behavior, vehicle maintenance needs, and fuel efficiency, while providing personalized insights for safe and efficient driving.</td></tr>
<tr><td>Member Name</td><td>Sub Objective</td><td>Tasks</td><td>Novelty</td></tr>
<tr><td>Munasinghe M.M.A.D
IT21269820</td><td>Design a scalable system using simple sensor inputs for analyzing driver behavior</td><td>• Develop ML models using accelerometer and GPS data to classify driving behavior.
• Enrich analysis using public datasets.
• Provide real-time feedback for safer and more efficient driving</td><td>Utilizes non-invasive data sources, provides actionable real-time insights, and enhances road safety using cost-effective technology.</td></tr>
<tr><td>Rashmika K.M.G.K
IT21389924</td><td>Develop predictive maintenance models accessible to non-connected vehicles.</td><td>• Build predictive models using maintenance logs and replacement histories.
• Simulate wear-and-tear data to complement datasets.
• Automate maintenance schedules to reduce downtime.</td><td>Offers predictive maintenance for vehicles without advanced diagnostics, combining simulated and real data to enable cost-efficient repairs.</td></tr>
</table>

Wijesingha W.M.R IT21251382	Integrate weather data for personalized driving safety recommendations.	• Analyze weather data combined with GPS driving patterns. • Identify correlations using clustering algorithms. • Provide real-time safety recommendations tailored to weather and road conditions.	Personalized safety insights combining weather and driving data, adapts to regional and seasonal variations, and enhances proactive safety measures.
Moraes V.J IT21274534	Create actionable fuel efficiency insights using regression models.	• Develop models predicting fuel consumption using driving and environmental data. • Incorporate vehicle health metrics into efficiency calculations. • Provide drivers with real-time fuel-saving tips through a user-friendly interface.	Takes a holistic approach to fuel efficiency by integrating behavioral, environmental, and vehicle health factors, offering real-time optimization for fuel savings. .

9. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Mr.	Samadhi	Rathnayake	
Co-Supervisor	Ms.	Supipi	Karunathilaka	
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

IT4010 – Research Project - 2024

Topic Assessment Form

<u>This part is to be filled by the Topic Screening Staff members.</u>

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes		No	

b) Does the proposed topic exhibit novelty?

Yes		No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes		No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes		No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

SLIIT UNI
THE KNOWLEDGE UNIVERSITY

IT4010 – Research Project - 2024

Topic Assessment Form

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

Staff Member's Name	Signature

*__Important__:

1. According to the comments given by the evaluator, make the necessary modifications and get the approval by the **Evaluator**.
2. If the project topic is rejected, identify a new topic, and request the RP Team for a new topic assessment.