**Design Document: Vehicle Hotspot Zone Identification**

**1. Introduction:**

The purpose of The Project is to design methodology for identifying hotspot zones related to engine coolant temperature in vehicles. The methodology combines rule-based guidelines and machine learning techniques to detect potential engine cooling problems.

**2. Objective:**

The primary objective is to develop a proactive monitoring and management system that can accurately identify hotspot zones indicating potential engine cooling issues in vehicles.

**3. Data Source:**

The dataset for this project is provided in the Google Drive link: [Dataset](https://drive.google.com/drive/folders/14-q-p-CJSpmRTYhCfWjN3qGMBHB7oIR?usp=sharing).

It includes historical data(1 month) of :

* Device ID
* Latitude
* Longitude
* Engine Coolant Temperature
* Vehicle Speed
* Engine Speed
* UTC

**4. Methodology:**

**Data Preprocessing:**

- Data Cleaning: Remove any duplicates, missing values, or outliers from the dataset.

- Feature Engineering: Extract relevant features from the dataset, such as date, time, vehicle ID, and engine coolant temperature.

- Data Transformation: Normalize or standardize the data to ensure uniformity in feature scales.

**Data Exploration:**

-Exploring data and generating insights by calculating Correlation on combination of factors affecting Engine coolant temperature.

- Plotting a box plot to determine thresholds and outliers.

**Rule-Based Guidelines:**

- Define threshold values for engine coolant temperature **(96’C**) based on industry standards and vehicle specifications.

- Establish rules to flag data points exceeding predefined thresholds as potential hotspot zones.

**Machine Learning Model:**

- Train a machine learning model using historical data to predict engine coolant temperature.

- Evaluate the model's performance using appropriate metrics such as accuracy

- Integrate the machine learning model with the rule-based guidelines to enhance hotspot zone detection accuracy.

**Hotspot Zone Identification:**

- Applied the rule-based guidelines and machine learning predictions to the dataset.

- Identify areas where engine coolant temperature exceeds predefined thresholds and classify them as hotspot zones.

- Generate visualizations such as heat maps or geographical plots to illustrate the hotspot zones.

**5. Implementation:**

- Develop a Python-based application using libraries such as Pandas, NumPy, Scikit-learn, and Matplotlib for data preprocessing, model training, and visualization.

- **Utilize Flask framework for building a web-based interface and Folium to generate the map** to interact with the hotspot zone identification system.

**6. Testing and Validation:**

- Testing of the application to ensure its functionality and accuracy in hotspot zone identification.

- Validate the results against real-world scenarios and expert opinions from automotive engineers or technicians.

**7. Deployment:**

- Deploy the finalized application on a production server accessible to stakeholders, including automotive manufacturers, fleet operators, and maintenance personnel.

**8. Maintenance and Updates:**

- Monitor the system's performance regularly and address any issues or bugs that arise.

- Incorporate feedback from users to improve the system's effectiveness and reliability.

- Keep the machine learning model up-to-date by retraining it periodically with new data.

This flowchart represents the sequential steps involved in the hotspot zone identification process, including data preprocessing, rule-based guidelines, machine learning model training, integration, hotspot zone identification, and visualization.

Conclusion:

The proposed methodology for identifying hotspot zones related to engine coolant temperature in vehicles combines the strengths of rule-based guidelines and machine learning techniques. By leveraging historical data and predictive analytics, the system aims to enhance vehicle maintenance practices and minimize the risk of engine cooling failures.