**Contribution Report of Team Member 1:**

* **Data Collection and Preprocessing**

**Problem Statement**

The primary goal of the project is to analyze vehicle movement patterns, monitor parking occupancy, and match vehicles to an approved database within a college campus using Edge AI. This comprehensive system aims to enhance traffic management, optimize parking space usage, and improve campus security by providing real-time insights and alerts.

**Objectives**

1. **Vehicle Movement Pattern Analysis:**
   * Track and analyze vehicle movements within the campus to identify peak traffic hours and congestion points.
2. **Parking Occupancy Monitoring:**
   * Continuously monitor parking lots and street parking areas to provide real-time occupancy data and optimize the usage of available spaces.
3. **Vehicle Matching:**
   * Identify and match vehicles entering the campus with a database of authorized vehicles to ensure compliance with parking permits and enhance campus security.

**Contribution Report for Team Member 1**

**Name:** Ashmitsingh Mala

**Role:** Data Collection and Preprocessing

**Tasks and Responsibilities**

1. **Data Collection:**

**Objective:** Capture high-quality data through various sensors and cameras strategically placed around the campus to monitor vehicle movements and parking occupancy.

**Activities:**

* + **Installation and Configuration:**
    - Installed high-resolution cameras at key locations such as entrances, exits, parking lots, and intersections to capture real-time video feeds.
    - Deployed motion sensors and RFID readers to track vehicle movements and gather additional data on parking occupancy.
    - Ensured the correct placement and configuration of parking sensors (e.g., ultrasonic and infrared sensors) to monitor the availability of parking spaces.
  + **Data Capture:**
    - Established a continuous data capture system to record video and sensor data for real-time analysis.
    - Implemented appropriate data storage solutions to handle the large volume of video and sensor data, ensuring data integrity and accessibility for further processing.

**Outcome:** Successfully captured high-resolution video feeds and sensor data, providing a robust dataset for vehicle movement and parking occupancy analysis.

1. **Data Preprocessing:**

**Objective:** Standardize and augment the collected data to enhance the accuracy and robustness of machine learning models used for vehicle detection, recognition, and analysis.

**Activities:**

* + **Image Preprocessing with OpenCV:**
    - Utilized OpenCV to resize, normalize, and augment images to ensure consistency and improve the performance of machine learning models.
    - Applied various image augmentation techniques such as rotation, scaling, and flipping to increase the diversity of the dataset and enhance model generalization.
  + **Annotation Tools:**
    - Used LabelImg for annotating images with bounding boxes to label vehicle positions, types, and license plates.
    - Developed custom scripts to parse annotation files from datasets, converting them into formats compatible with machine learning frameworks like TensorFlow and PyTorch.

**Outcome:** Created a well-preprocessed and annotated dataset that is ready for model training, ensuring high-quality input for subsequent stages of the project.

* **Edge Case Handling Tests**

To ensure the robustness and reliability of the data collection and preprocessing pipeline, several edge cases were identified and handled:

1. **Variable Lighting Conditions:**
   * **Test:** Captured images and videos during different times of the day and in various weather conditions (e.g., sunny, cloudy, rainy) to account for changes in lighting.
   * **Solution:** Applied histogram equalization and adaptive thresholding techniques using OpenCV to normalize lighting conditions across images.
2. **Occlusions:**
   * **Test:** Simulated scenarios where vehicles are partially occluded by other objects (e.g., trees, poles, other vehicles).
   * **Solution:** Employed image augmentation techniques such as random cropping and occlusion to improve model robustness against partially obscured objects.
3. **Camera Placement Variability:**
   * **Test:** Analyzed data from cameras placed at different angles and heights to understand the impact on data quality.
   * **Solution:** Standardized camera placement guidelines and used geometric transformations in OpenCV to correct for angle distortions.
4. **Sensor Failures:**
   * **Test:** Simulated sensor malfunctions or data dropouts to test system resilience.
   * **Solution:** Implemented redundancy by deploying multiple sensors in critical areas and developing algorithms to interpolate missing data.
5. **High Traffic Density:**
   * **Test:** Collected data during peak hours to ensure the system can handle high traffic volumes.
   * **Solution:** Used efficient data processing pipelines and optimized algorithms to manage and analyze large datasets in real-time.

**Evaluation and Question Handling**

During evaluation, I am prepared to answer questions related to the following aspects of my contribution:

1. **Camera and Sensor Selection:**
   * Justification for choosing specific types of cameras and sensors.
   * Configuration settings and placement strategies.
2. **Data Preprocessing Techniques:**
   * Detailed explanation of preprocessing steps using OpenCV.
   * Annotation processes and compatibility with machine learning frameworks.
3. **Edge Case Handling:**
   * Identification of potential edge cases and the specific solutions implemented.
   * Impact of these solutions on overall system performance and reliability.
4. **Challenges and Solutions:**
   * Key challenges faced during data collection and preprocessing.
   * How these challenges were addressed to ensure high-quality data for model training and analysis.