**Contribution Report for Team Member 3:**

* **Parking Occupancy Monitoring and Vehicle Matching**

**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 3**

**Name:** Aboli More

**Role:** Parking Occupancy Monitoring and Vehicle Matching

**Tasks and Responsibilities**

1. **Parking Occupancy Monitoring:**

**Objective:** Monitor parking occupancy in real-time to optimize the use of parking spaces and reduce the time spent searching for parking.

**Activities:**

* + **Implement Mask R-CNN:**
    - Utilized Mask R-CNN (Region-based Convolutional Neural Networks) for image segmentation to accurately identify and segment parked vehicles in real-time.
    - Trained the Mask R-CNN model using annotated parking lot images from the Stanford Cars Dataset and Open Images Dataset.
  + **Real-Time Processing with OpenCV:**
    - Integrated Mask R-CNN with OpenCV for real-time processing of video feeds from cameras monitoring parking areas.
    - Developed algorithms to detect parking space occupancy status, calculate the number of available spaces, and provide real-time updates.

**Outcome:** Successfully monitored parking occupancy in real-time, providing accurate data on available parking spaces and reducing search times for parking.

1. **Vehicle Matching:**

**Objective:** Identify and match vehicles entering the campus with a database of authorized vehicles to enhance campus security and ensure compliance with parking permits.

**Activities:**

* + **Tesseract OCR for License Plate Recognition:**
    - Used Tesseract OCR to extract and recognize license plate numbers from captured images.
    - Preprocessed images using OpenCV to enhance the accuracy of OCR, including steps like image resizing, grayscale conversion, and noise reduction.
  + **Database Integration:**
    - Developed a database of authorized vehicles using SQL or NoSQL databases to store license plate numbers and associated information.
    - Implemented matching algorithms to compare recognized license plates with the database entries and generate real-time alerts for unauthorized or suspicious vehicles.

**Outcome:** Successfully identified and matched vehicles entering the campus with the authorized vehicle database, enhancing security and compliance with parking regulations.

* **Edge Case Handling Tests**

To ensure the robustness and reliability of the parking occupancy monitoring and vehicle matching systems, several edge cases were identified and handled:

1. **Low-Light Conditions:**
   * **Test:** Evaluated the performance of Mask R-CNN and Tesseract OCR under low-light conditions, such as during nighttime or in poorly lit areas.
   * **Solution:** Applied image enhancement techniques, such as histogram equalization and adaptive thresholding, to improve visibility and OCR accuracy in low-light conditions.
2. **Obstructed License Plates:**
   * **Test:** Tested the system's ability to recognize partially obstructed or dirty license plates.
   * **Solution:** Implemented advanced image preprocessing techniques and fine-tuned Tesseract OCR parameters to enhance recognition accuracy for obstructed plates.
3. **Dynamic Backgrounds:**
   * **Test:** Assessed the accuracy of parking occupancy monitoring in areas with dynamic backgrounds, such as moving shadows or pedestrians.
   * **Solution:** Used background subtraction algorithms and dynamic thresholding in OpenCV to accurately segment and identify parked vehicles despite dynamic backgrounds.
4. **High Traffic Density:**
   * **Test:** Analyzed system performance during peak traffic times when parking areas are highly occupied.
   * **Solution:** Optimized Mask R-CNN for efficient processing and ensured real-time performance through model pruning and hardware acceleration.
5. **License Plate Variability:**
   * **Test:** Ensured the system could accurately recognize license plates of different styles, fonts, and formats.
   * **Solution:** Trained Tesseract OCR on a diverse dataset of license plate images to improve its generalization across different plate styles.

**Evaluation and Question Handling**

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

1. **Mask R-CNN Implementation:**
   * Explanation of how Mask R-CNN was used for parking occupancy monitoring and the specific steps taken to ensure accurate segmentation of parked vehicles.
   * Details on the training process, including dataset selection and model optimization techniques.
2. **Real-Time Processing with OpenCV:**
   * Methods used to integrate Mask R-CNN with OpenCV for real-time video feed processing.
   * Algorithms developed to detect parking occupancy and provide real-time updates.
3. **Tesseract OCR for License Plate Recognition:**
   * Steps taken to preprocess images and enhance OCR accuracy, including specific OpenCV techniques.
   * How Tesseract OCR was fine-tuned and integrated with the vehicle matching system.
4. **Database Integration:**
   * Design and implementation of the database for storing authorized vehicle information.
   * Matching algorithms developed to compare recognized license plates with database entries and generate real-time alerts.
5. **Edge Case Handling:**
   * Identification of potential edge cases and the specific solutions implemented to handle them.
   * Impact of these solutions on overall system performance and reliability.
6. **Challenges and Solutions:**
   * Key challenges faced during parking occupancy monitoring and vehicle matching.
   * How these challenges were addressed to ensure accurate and reliable system performance.