Vehicle Movement Analysis and Insight Generation in a College Campus using Edge AI

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Problem Statement

Managing vehicle movement and parking within a college campus is often challenging due to the high volume of vehicles and limited parking spaces. Traditional methods of monitoring vehicle entry/exit and managing parking occupancy involve manual processes, which are time-consuming and prone to errors. Additionally, ensuring that only authorized vehicles enter the campus requires constant vigilance and significant manpower. The need for an efficient, automated system to monitor, analyze, and manage vehicle movements and parking is crucial for improving campus security and optimizing space utilization.

Unique Idea Brief (Solution)

This system leverages Edge AI to analyze real-time image data from cameras, track vehicle movements, monitor parking occupancy, and match vehicles to an approved database. Key components include:

- Image Preprocessing: Resize and convert images to grayscale for efficient processing.
- Vehicle Movement Analysis: Track and visualize vehicle entry/exit times to identify peak hours.
- License Plate Recognition: Use Tesseract OCR for accurate license plate recognition.
- Real-Time Monitoring: Provide up-to-date insights on parking occupancy and vehicle movements.
- Edge AI: Reduce latency and improve analysis speed compared to cloud-based methods.

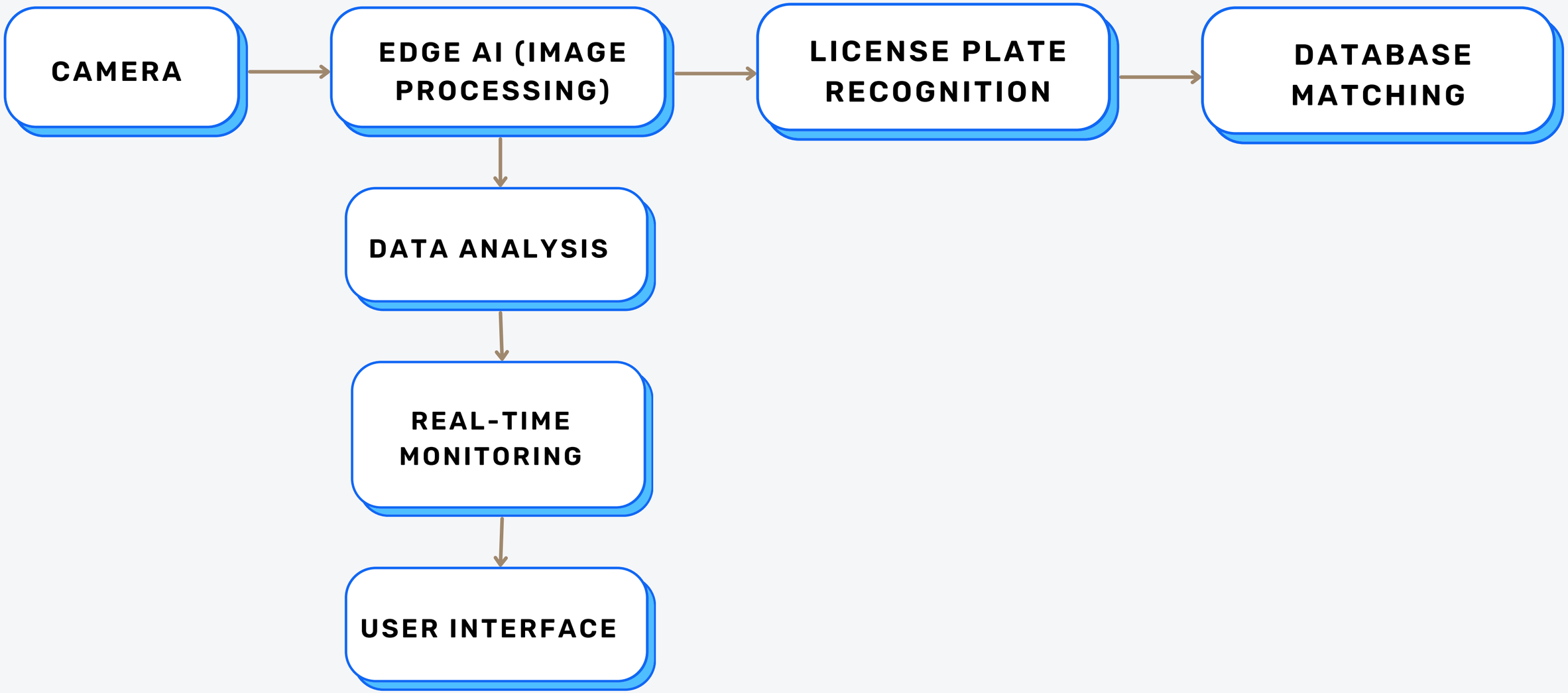
Features Offered

- Image Preprocessing: Resize and grayscale conversion.
- Vehicle Movement Analysis: Entry/exit time visualization.
- License Plate Recognition: Accurate OCR-based recognition.
- Vehicle Matching: Match plates against an approved database

Process flow

- Image Acquisition: Cameras capture real-time images of vehicles entering and exiting the campus.
- Image Preprocessing: Images are resized and converted to grayscale for efficient processing.
- License Plate Recognition: Tesseract OCR extracts and filters license plate text from preprocessed images.
- Database Comparison: Recognized plates are compared against an approved vehicle database for authorization.
- Data Analysis: Vehicle entry/exit times are analyzed to generate insights on movement patterns and peak hours.
- Real-Time Monitoring: Continuous monitoring of parking occupancy and vehicle movements provides live updates.
- User Interface: Flask web application displays real-time insights and authorized vehicle

Architecture Diagram



Technologies used

Programming Languages: Python (OpenCV, pandas, pytesseract)
AI Framework: YOLOv3 for object detection
Web Framework: Flask for building the web interface
Data Visualization: Matplotlib and Seaborn for generating insights
OCR Tool: Tesseract for license plate recognition
Deployment: Edge computing for real-time data processing

Team members and contribution:

1. Team Leader: Siddhesh Karemore
Role: Coordinated project tasks and team activities.
Contribution:
Contributed to real-time data monitoring and analysis.
2. Team Member: Hrishikesh Kakde
Role: Lead Developer and AI Specialist
Contribution:
Implemented image preprocessing, license plate recognition, and real-time data processing.
Designed and integrated YOLOv3 for object detection and Tesseract OCR.
Led the development of the Flask-based web interface and visualization tools.
3. Team Member: Salfiya Anzar
Role: Backend Developer and Data Analyst
Contribution:
Assisted in data preprocessing and database management tasks.
Contributed to real-time data monitoring and analysis.

Conclusion

The Vehicle Movement and Parking Management System using Edge AI, led by Hrishikesh Kakde, has successfully leveraged advanced AI technologies to monitor vehicle movements and optimize parking space utilization on campus. With its robust architecture and user-friendly interface, the system provides real-time insights and enhances campus security. Moving forward, the project aims to expand its applications and continue refining its capabilities for broader deployment.

Thank you!