Deep Learning-Based Vehicle Front-Back Classification

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Introduction

- Vehicle orientation classification is essential for ITS applications like parking systems and toll collection.

- Focus on detecting vehicle front-back orientation in challenging conditions (lighting, weather, vehicle diversity).

- Utilizes CNN architectures for feature extraction.

- Goal: Develop a robust model for real-world traffic management applications.

Literature Review

Title	Methodology	Dataset	Result
"Classification of Vehicle Images through Deep Neural Networks" [1]	Used DNNs to classify vehicle images by orientation in ITS applications.	Custom dataset with diverse vehicle angles and conditions.	Accuracy: **95%**, indicating robust performance across varied conditions.
"Advancements in Image Classification using CNN "[2]	Reviewed CNN evolution for image classification tasks, emphasizing robustness.	Reviewed datasets like ImageNet.	Improvement in accuracy by ~10% using advanced architectures.
"VoNet: Vehicle Orientation Classification Using CNN" [3]	Proposed VoNet for front-back vehicle classification.	Custom dataset with multiple vehicle orientations.	Accuracy: 92.5%

Literature Review

Title	Methodology	Dataset	Result
Classification of Vehicles Using Histogram Oriented Gradients [4]	Modified HOG features for vehicle type classification.	PASCAL VOC dataset.	Accuracy: 88% (with modifications).
Real-Time Vehicle Classification Using CNN [5]	Developed a CNN-based system for real-time classification.	Custom real-time traffic dataset with diverse vehicle types.	Real-time accuracy: 93.2%.
Advancing Image Understanding in Poor Visibility [6]	Examined deep learning methods for vehicle detection in poor visibility.	Dataset with low-visibility conditions (fog, rain).	Model accuracy dropped ~20% under poor visibility.

Literature Review

Title	Methodology	Dataset	Result
Vehicle Shape and Color Classification Using CNN [7]	Used CNNs to classify vehicles based on shape and color.	Dataset with annotated shapes and colors.	Accuracy: 89.5%.
Evaluating ResNet for Image Recognition [8]	Benchmarked ResNet's performance for orientation detection.	ImageNet dataset.	Accuracy: 96.1% (ResNet-50).
Evaluation of Deep Learning for Semantic Segmentation of Car Parts [9]	Evaluated algorithms for car part segmentation, aiding orientation detection.	Car Parts Dataset with annotated parts.	IoU (Intersection over Union): 82%.

Literature Review

Title	Methodology	Dataset	Result
Deep Learning-Based Vehicle Orientation Estimation [10]	Analyzed environmental impacts (lighting, weather) on orientation classification.	Custom dataset under varied conditions.	Accuracy: 90% under normal, 78% under harsh conditions.
Fast Real-Time Vehicle Detection Using Deep Learning [11]	Proposed a real-time detection system for ITS.	KITTI dataset.	Detection accuracy: 91%, latency: 50ms per frame.
Real-Time Orientation Classification and Viewpoint-Aware Re-ID [12]	Combined orientation classification with re-identification for tracking.	Multi-view vehicle dataset.	Orientation accuracy: 94%, re-ID accuracy: 89%.

Literature Review

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Deep Learning Techniques for Vehicle Detection [13]	Reviewed techniques for vehicle detection and classification in images/videos.	Reviewed KITTI and ImageNet datasets.	Best methods achieved >90% accuracy for classification.
Car Full View Dataset: Fine-Grained Orientation Prediction [14]	Introduced a dataset for fine-grained orientation prediction, tested models.	Car Full View Dataset with multiple vehicle perspectives.	Accuracy: 93.4%.
Vehicle Orientation Classification in Challenging Conditions [15]	Proposed hybrid CNN-LSTM for better classification in occlusion-heavy scenes.	Dataset with high occlusion scenarios.	Accuracy: 85% (10% better than CNN alone).

Car Parts Dataset:

Back view:

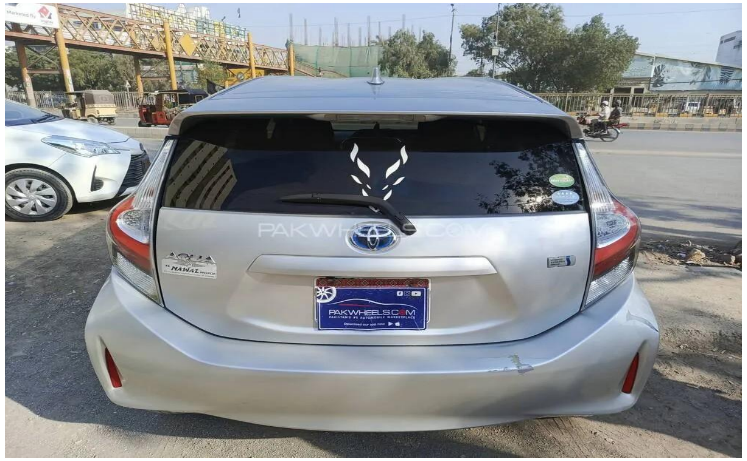
Pakwheels:

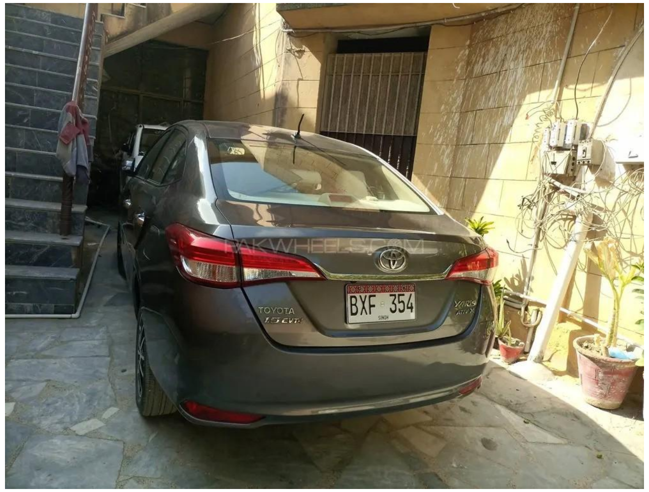
Front view:




Pakwheels:

Back view:





Methodology

- **Dataset:** 900 images , augmented for robustness.
- **Feature Extraction:** CNN models (MobileNet, VGG) used for visual feature extraction.
- **Classification:** MobileNetV2 with sigmoid activation vs. MobileNet + SVM classifier.
- **Training:** 5-fold cross-validation with evaluation metrics (accuracy, precision, recall, F1-score).

Results

- **MobileNetV :**
  - **Test Loss:** 0.532
  - **Test Accuracy:** 77.08%
- **VGG + SVM:**
  - Accuracy: 0.9695
  - Precision: 0.9794
  - Recall: 0.9596
  - F1 Score: 0.9694

- **Performance:** Excellent results with VGG+ SVM across all metrics.

Conclusion and future work

- **Conclusion:** MobileNet + SVM outperforms MobileNetV2 in accuracy and other metrics.

- **Future Work:** Expand dataset with more challenging conditions, explore more CNN Models

- **Real-Time Testing:** Integrate for real-time traffic monitoring and ITS applications.

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Thank You