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Safe and Efficient Traffic Obstacle Detection using Fine-tuned Modified Faster R-CNN

(Paper ID 664)

Authors:

Jyoti Madake, Shruti Korpade, Hemal Kulkarni, Rahul Kumbhar, Shripad Bhatlawande

Vishwakarma Institute of Technology, Pune

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INTRODUCTION:

➔ Challenges in recognizing road obstacles

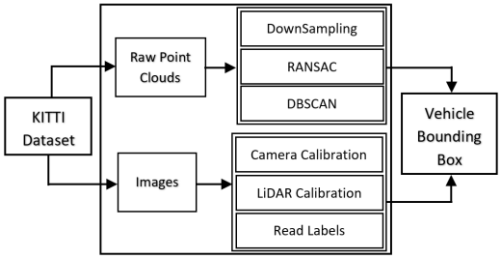
➔ Identification and Prediction of obstacles to avoid traffic jam

➔Traffic Obstacle Detection by Fine-tuning Faster R-CNN

LITERATURE SURVEY

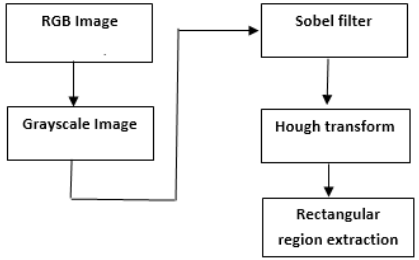
Visualization of 3D Point Clouds for Vehicle Detection Based on LiDAR and Camera Fusion
[1]

- Detection of vehicles using Camera and Lidar data.
- RANSAC, DBSCAN Algorithms used for visualization and clustering of the LiDAR point cloud.



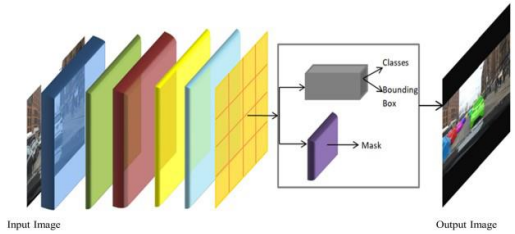
Preprocessed Faster RCNN for Vehicle Detection
[2]

- Uses Sobel edge operator and Hough Transform for lane detection.
- Extracts a Rectangular region from lane coordinates for reduced ROI.



Vehicle Detection through Instance Segmentation using Mask R-CNN for Intelligent Vehicle System
[3]

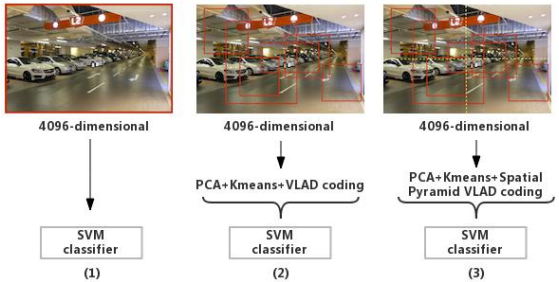
- Implementation of Mask R-CNN using transfer learning for vehicle detection.
- Segmentation-based approach adopted for precise vehicle identification.



Traffic scene recognition based on deep CNN and VLAD spatial pyramids

[4]

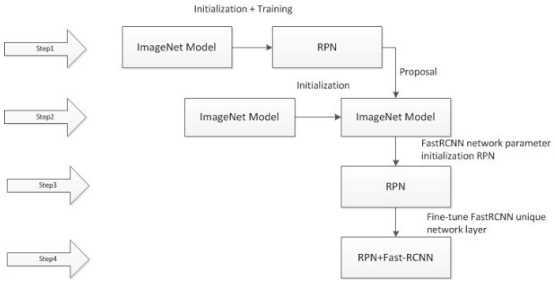
- Vector of Locally Aggregated Descriptors (VLAD) encoding is used to capture global contextual information.
- CNN features of image patches are encoded using VLAD Spatial pyramids.



Vehicle type detection based on deep learning in traffic scene

[5]

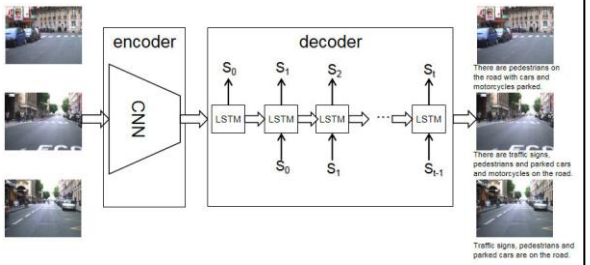
- Application of Faster RCNN framework and improvisation on RPN networks.
- Detection and recognization of three common types of vehicles in traffic scenes.



The traffic scene understanding and prediction based on image captioning

[6]

- The paper introduces an image captioning model.
- The solution solves feature fusion, general object recognition, and low-level semantic understanding problems.



❖Research Gap

- **Unable to detect road obstacles**
- **Challenges like Occlusion, Illumination Change, Response**
- **Expensive Real-time detection systems**
- **Low Accuracy**

❖Novelty

Approach: Fine tuning of Faster R-CNN

Real-time Detection and decision-making

Lowest Processing Time and Training Loss

Highly Accurate Lightweight System

METHODOLOGY

Dataset and Preprocessing:

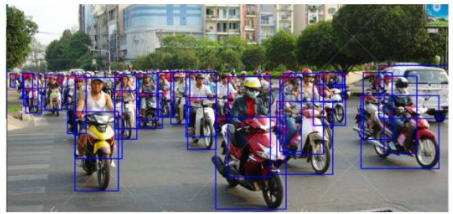



Sr. No.	Classes	No. of Training Images	No. of Testing Images
1	Pedestrians	944	235
2	Traffic Signs	551	162
3	Cars	1015	177
4	Bikes	331	82
5	Zebra Crossing	176	36
	Total	**3017**	**692**

- ➔ Dataset consists of 3709 RGB images.
- ➔ Algorithm uses data transformations for feature extraction using a ResNet-50 model.

System Block Diagram

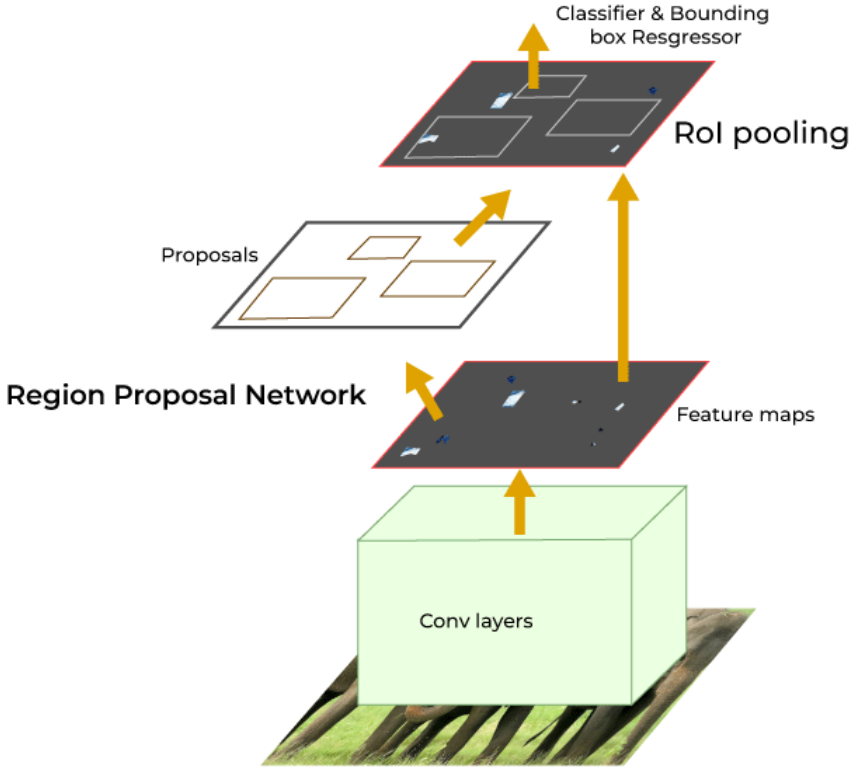
Input: Video Stream or Image → Train ResNet-50 model on custom dataset, for classification → Evaluate performance of model, to correctly classify images from test dataset → Demonstrate use of the model to predict class of object in image → Use of Faster R-CNN to draw bounding boxes around objects in video → Output: Traffic Object Detection Results (Bounded Boxes)



Faster R-CNN Architecture

Faster R-CNN architecture consists of two components:

1) **Region Proposal Network (RPN)**
2) **Fast R-CNN detector**

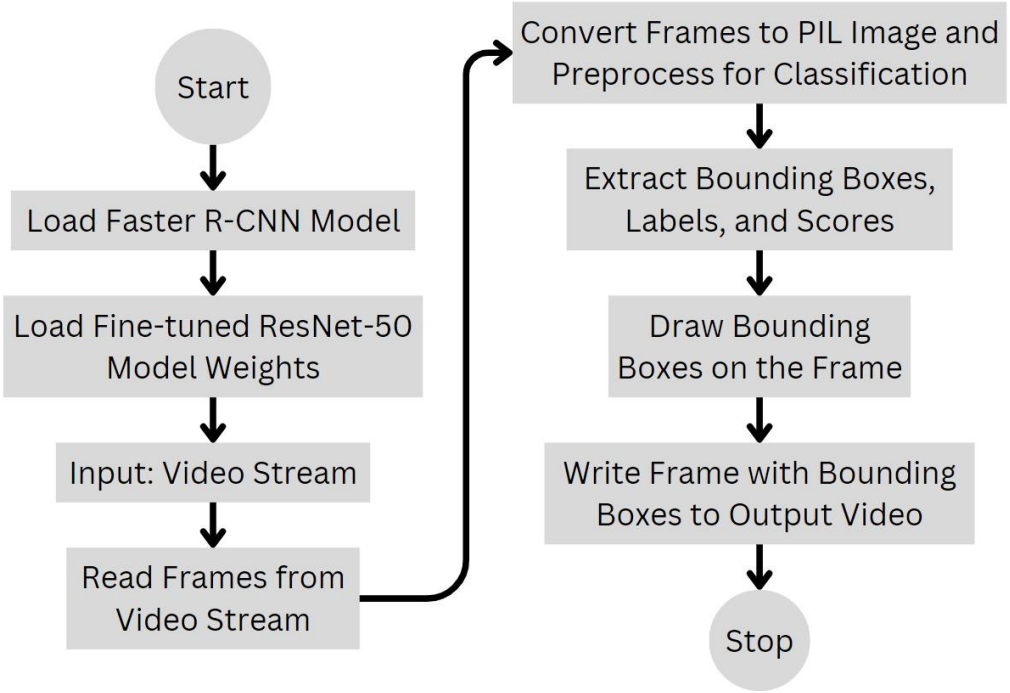


Credits for Image:
https://www.geeksforgeeks.org/faster-r-cnn-ml/

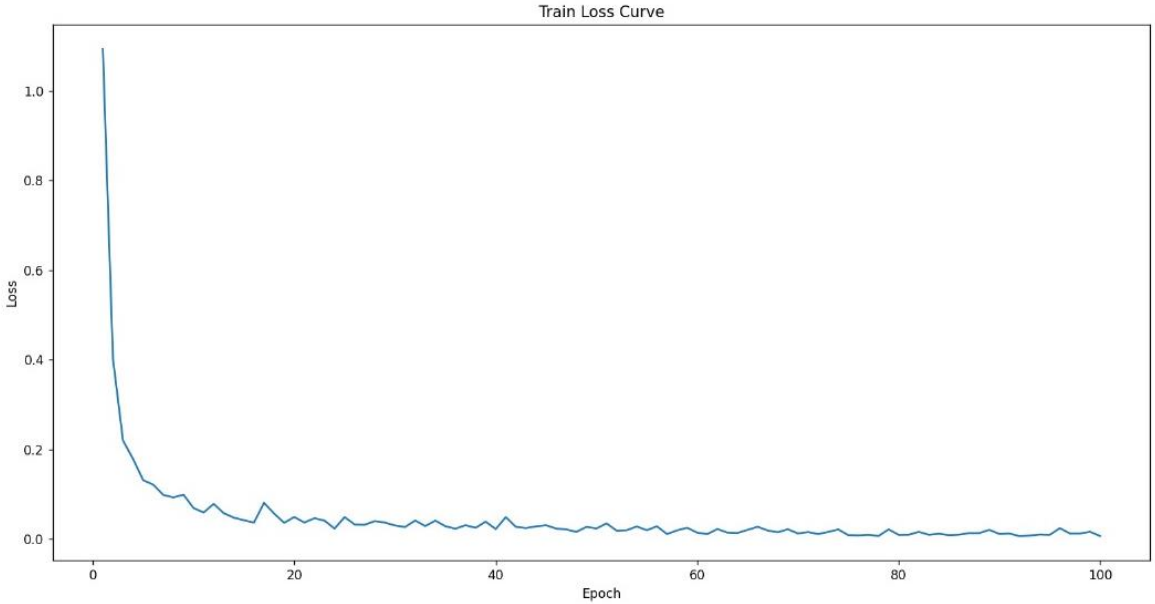
Proposed Model :

★ The algorithms are as follows:

- ResNet50
- Faster RCNN
- Stochastic Gradient Descent
- Cross Entropy
- Fine Tuning



Results and Discussion:

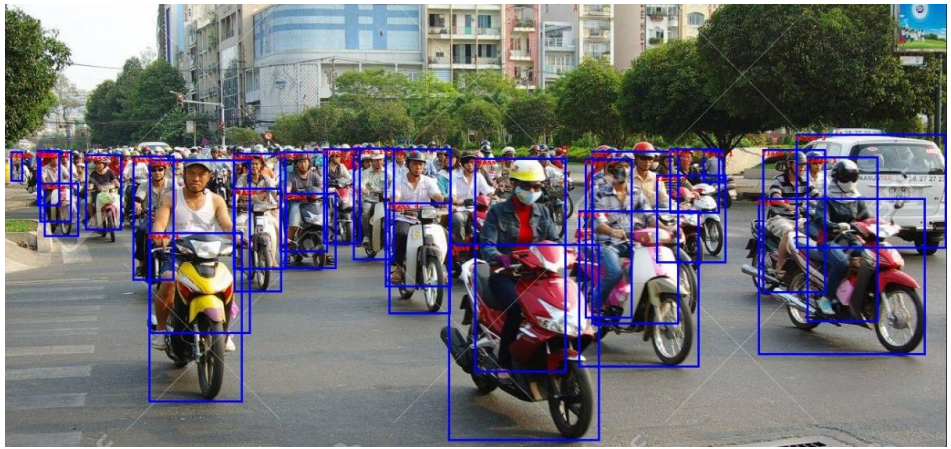


No. of Epochs	Test Accuracy	Final Training Loss	Process Inference: 156 milliseconds
100	98.2659%	0.0326	'ASUS TUF dash Gaming F15 Core i5 12th Gen 12500H - (8 GB/512 GB SSD/4 GB Graphics/NVIDIA GeForce RTX 3050)' machine

Results and Discussion:

INPUT:

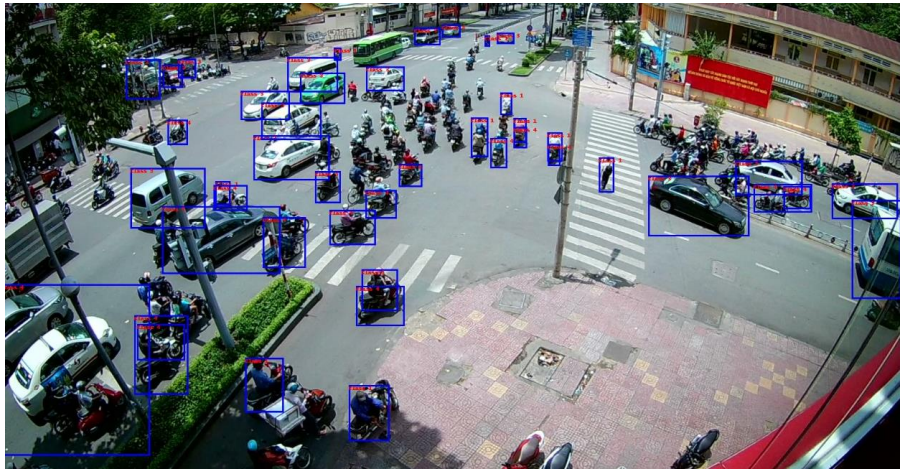
OUTPUT:



Results and Discussion:

SCENARIO 1:

SCENARIO 2:



Advantages

- ➔ Precise localization of bikes, cars, and pedestrians.
- ➔ High Accuracy: 98.27%
- ➔ Inference Time of 0.156 milliseconds
- ➔ Real-time decision-making

Limitations

- ➔ Blurred or noisy input images can leads to wrong prediction.
- ➔ Semantic Segmentation, Lane Detection, Traffic Scene Graph Understanding
- ➔ Increasing no. of classes in the dataset for detection of other obstacles.

Comparison of Proposed System:

Model	Accuracy (mAP)	Model Size (MB)	Dataset	Bounding box Loss
Proposed Model	**91%**	**92**	**Customized**	**0.0326**
Faster R-CNN (Resnet101)	85.60%	200	COCO, Pascal VOC2012	0.12
Fast R-CNN	70%	150	Pascal VOC2007	Smooth L1
R-CNN	66%	75	Pascal VOC2007	Smooth L1
YOLOv2 (Darknet19)	78.60%	35	Pascal VOC2007	0.057
SSD512 (VGG16)	80%	25	COCO, Pascal VOC2012	Smooth L1
RetinaNet	73.80%	75	COCO	Focal Loss

Conclusion

- ➔ Fine-tuned Modified Faster R-CNN system detects traffic obstacles with **98.27% accuracy**.
- ➔ Proposed Model is a lightweight system having **92 MB model size**.
- ➔ Final **Bounding Box training loss** was calculated as **0.0326**.
- ➔ The proposed system has an **Inference time of 156 milliseconds**.

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THANK YOU

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