Comparitive Analysis of Heuristic Techniques for vehicle movement detection

- **BTP CODE : B24SMP03**

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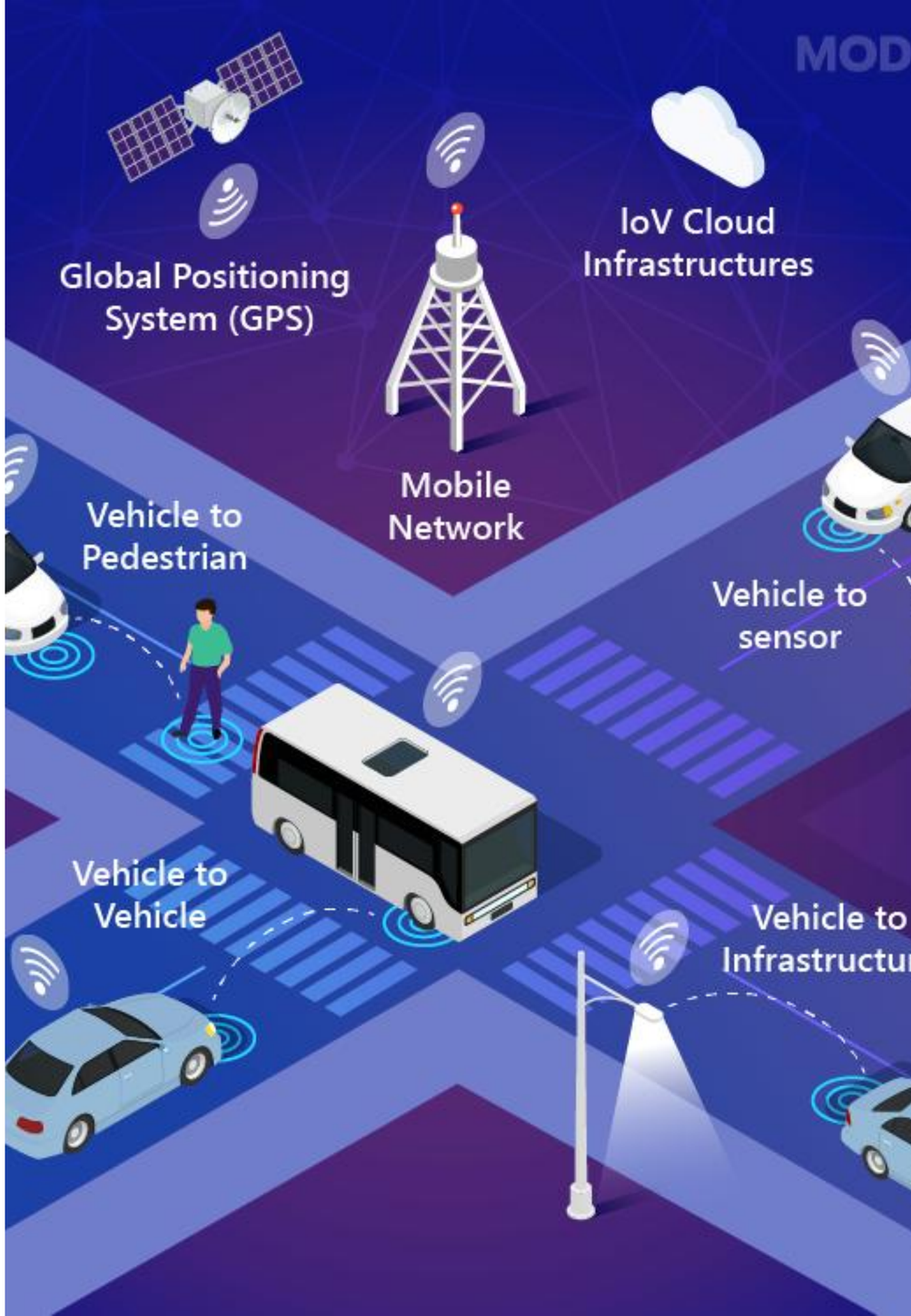
Introduction

- The **Intelligent Transportation System (ITS)** is a technology in which all vehicles and infrastructure elements, such as road signs and traffic signals, are connected to central control.

- There are advanced applications in ITS, that strive to provide innovative services related to different modes of transport and traffic management.

- ITS enables cars and roads to communicate, forming a smart system for safer, connected transportation.

- Various forms of wireless communications technologies have been proposed for intelligent transportation systems.



Why ITS needed?

01

- Improve flow efficiency
- Prevent accidents
- Provide drivers with actual information

02

- Make transportation system more efficient
- Also secure, and safer

03

- Tackle rising congestion

04

- It is not possible to build enough new roads or to meet the demand.

Traffic signal priority

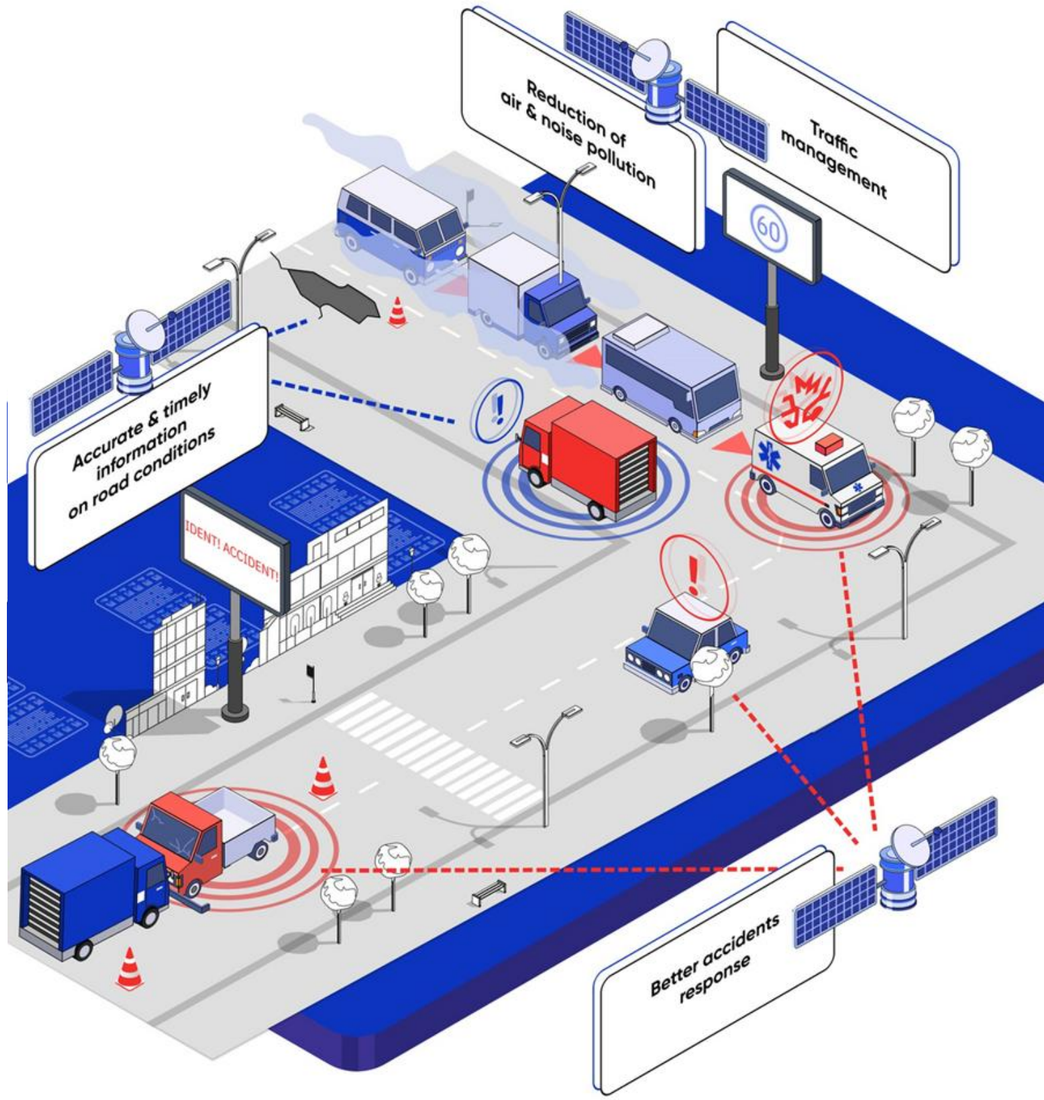
Automatic Speed Enforcement

Applications of ITS

Lane Departure Warning Systems

Emergency Vehicle Notification Systems

Collision Avoidance mechanism



https://senlainc.com/blog/intelligent-transportation-system-importance/

Why Direction of motion is required?

- These Applications requires consideration of various parameters.

- Parameters include **Traffic Volume, Vehicle Speed, Delay, Environmental Conditions, Travel Time etc.**

- In order to conduct an analysis of the different parameters , it is required to identify the various directions of motion (lanes) within a given video sequence.

Existing Issues in lane Detection

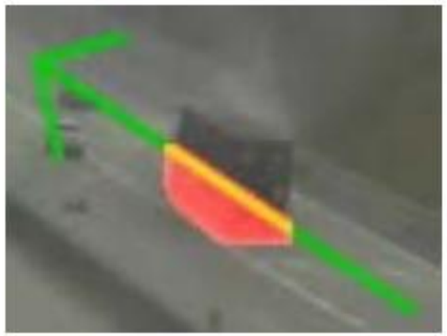
- Poor Weather Conditions
- Sun Glare
- Reflective Surfaces
- Complex road geometries
- Different types of camera angles
- Worn-out Road Markings

Literature Survey

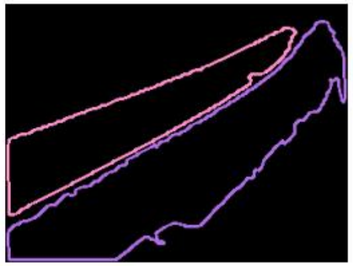
[1] Robust Road Region Extraction in Video Under Various Illumination and Weather Conditions

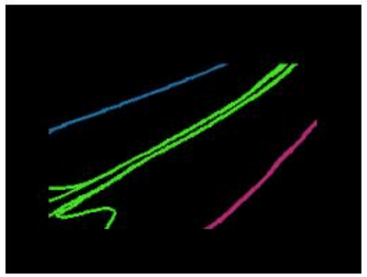
IEEE 4th International Conference on Image Processing, Applications and Systems (IPAS), pp., 2020

- **Initial Road Region Approximation**
  - Global Foreground Modelling(GFM)
  - Effective Blob Tracking
  - Foreground mask is used to crop ,to filter out non-road pixels
  - Generating Probability map
  - Histogram model
  - After updating the probability map, otsu''s threshold is applied



- **Integration of temporal features with estimated road region**
  - Flood-fill Algorithm
  - To define the limiting boundaries of flood fill algorithm, canny edge detection is used
  - Principal component analysis (PCA) method is applied on each set of re-sampled points
  - Estimating the road boundaries





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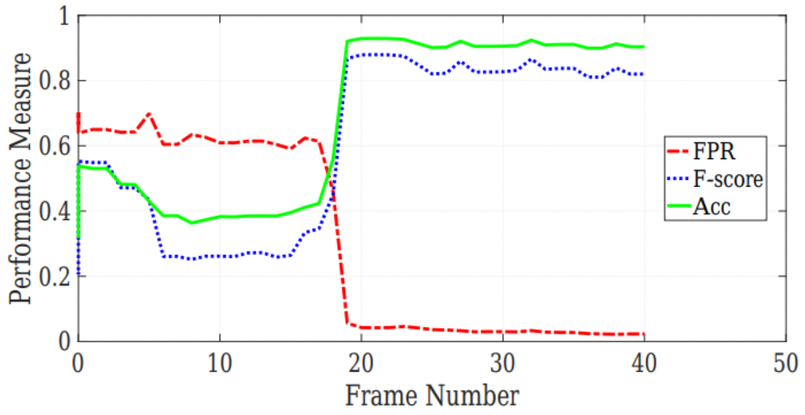
- **Evalaution Metrics**
  - True Positive , True Negative , False Positive , False Negative
  - Accuracy, Precision, Recall, F1-score,FPR
  - Under(e) vs Over(b,d) Segmentation
- **Conclusion**
  - Adaptive and fully automatic method
  - Proposed method shows good performances in videos of different sizes

(a) Video 1 (b) Video 2 (c) Video 3 (d) Video 4 (e) Video 5

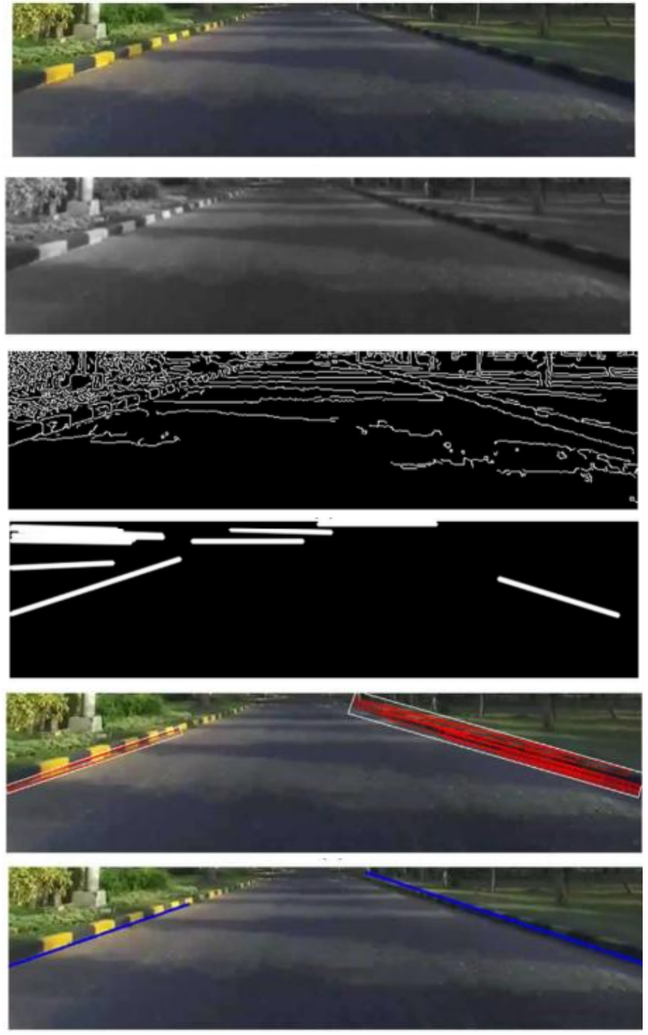


Video #	1	2	3	4	5
Precision	0.98	0.87	0.94	0.93	0.89
Recall	0.96	0.93	0.95	0.94	0.96
F-Score	0.97	0.90	0.95	0.94	0.92

[2] Lane Detection Using Edge Detection and Spatio-Temporal Incremental Clustering

International Seminar on Intelligent Technology and Its Applications (ISITIA),pp. ,2021.

- **Region of Interest (ROI) Selection**
  - Area selected for processing
  - Selection of Vanishing Point
  - Reduces the computation of processing
  - Increasing the speed of data processing.
- **Grayscalling and Noise Reduction**
  - Convert an image from RGB to grayscale
  - Noise reduction is used to smooth out sharp intensity changes
  - Used Gaussian smoothening with 3 x 3 kernels
- **Lane Boundaries Object Selection**
  - Canny edge detection
  - Results in binary image, helps data processing further easier
  - Hough Transform



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- **Spatio Temporal Incremental Clustering**
  - Connected components within a frame are clustered
  - The existing clusters from the previous frame act as initiation clusters
  - If a new connected component matches the criteria set for an initiation cluster, it is added to the corresponding cluster from the previous frame
  - Connected component does not meet the criteria, it becomes the first member of the new cluster.
- **Curve Fitting**
  - A curve is fitted on the lane clusters to represent or show the lanes by using least square fitting technique
- **Conclusion**
  - No training on any type of road dataset required
  - Reduces the space and time complexity
  - This method helps detecting the boundary on a road that does not have line marking
  - This approach allows the to adapt dynamically to variations in the scene

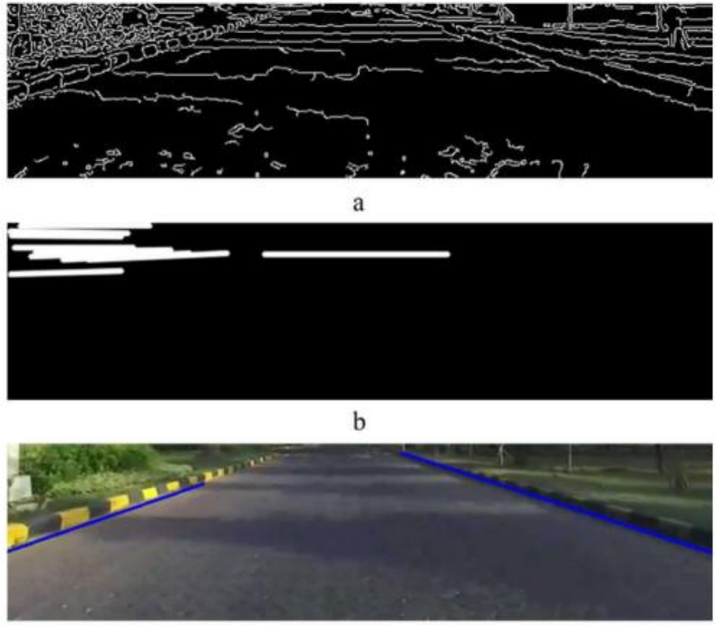
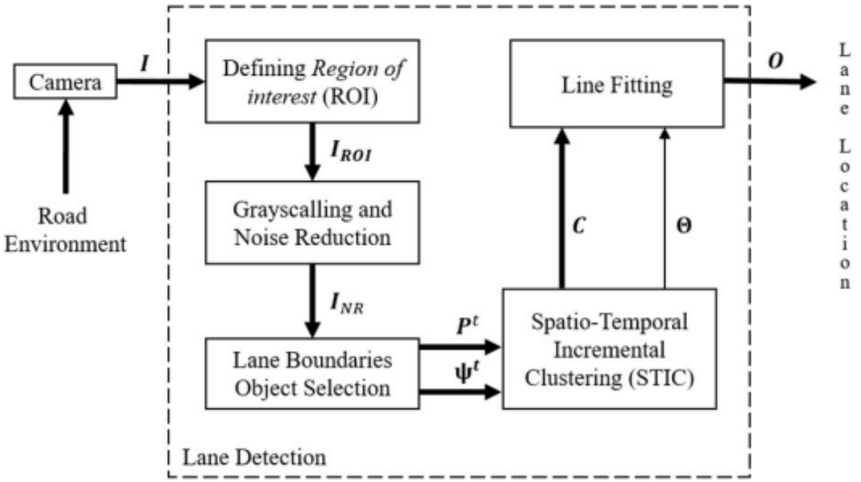


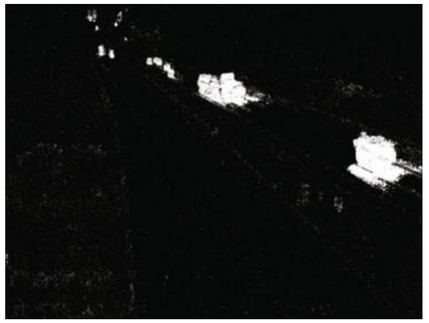
Fig. 5. One of the frames that hough transform cannot detect the line from canny edge detection. (a) Canny edge detection result. (b) Hough transform result. (c) STIC result.



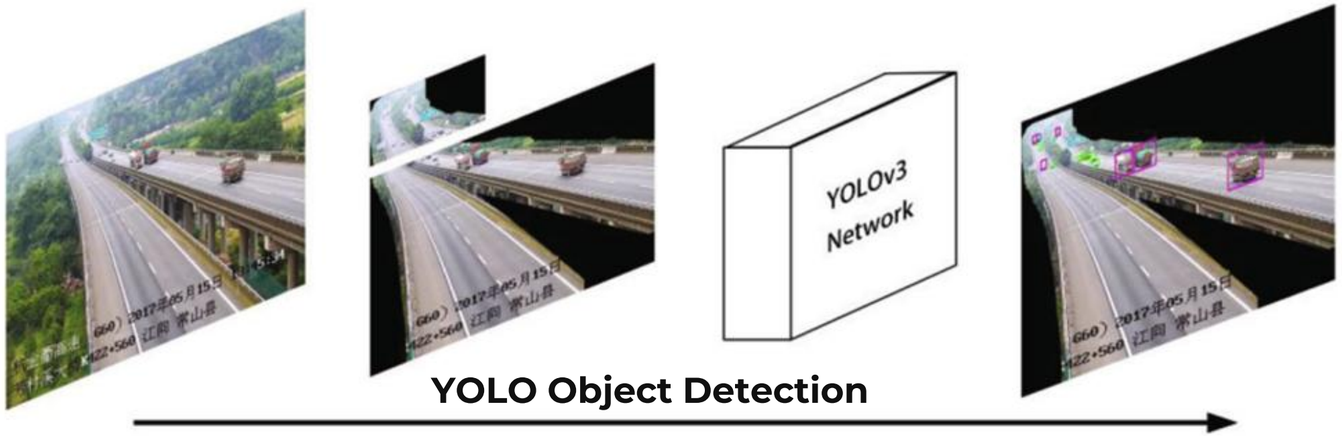
[3] Vision-based vehicle detection and counting system using deep learning in highway scenes

European Transport Research Review, SpringerOpen, pp., 2019.

- **Road Surface Segmentation**
  - Background and Foreground Extraction
  - Image is smoothed by a Gaussian filter
  - Flood Fill Algorithm used to fill the road surface area
  - Division of Remote and Proximal area from segmented frame



- **Vehicle detection using YOLO**
  - The image is divided into grids. is responsible for predicting the object
  - Each grid unit will have different bounding boxes of different scales for one object
  - The box that has the largest overlapping area will be the final prediction result
  - Detection speed is fast, and the detection accuracy is high



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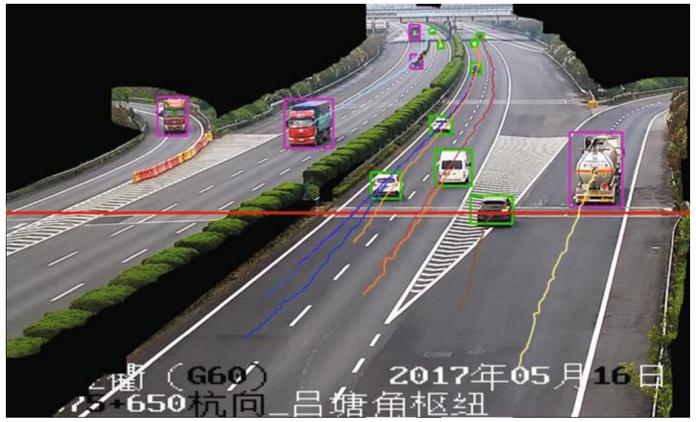
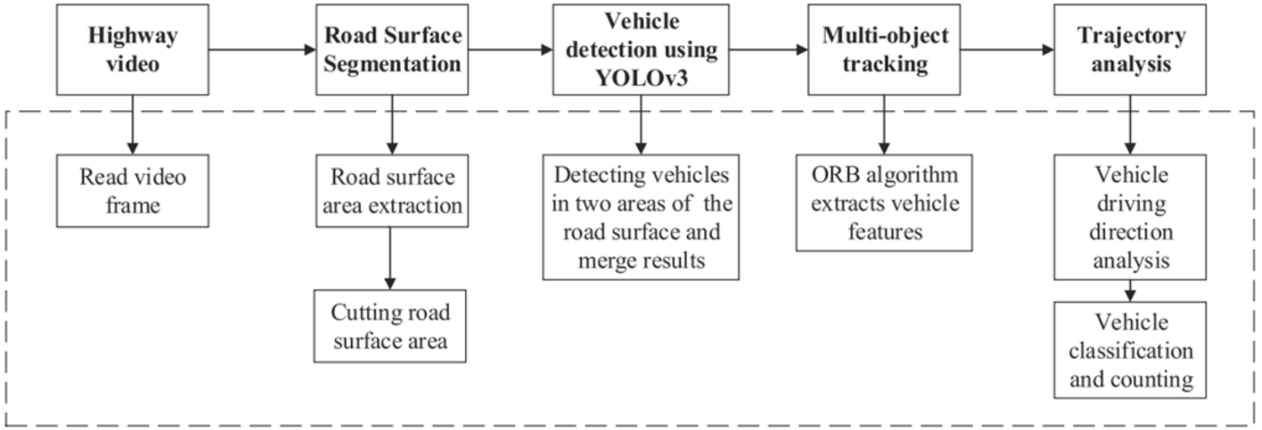
- **Multi-object tracking**
  - ORB algorithm to extract feature points in the object detection box
  - Defines a threshold based on the size of the vehicle object box to associate the same object across different frames



- **Trajectory Analysis**
  - Using the direction of vehicle tracking trajectory, we distinguish the direction of the vehicle
  - A detection line is placed in the traffic scene image for vehicle classification
  - The road traffic flow is counted



Overall flow of the method

- **Results & Evalution metrics**
  - Average Precision, Mean Average Precision, Average Accuracy, among different classes
  - The results show that the average accuracies of vehicle driving direction and vehicle counting are 92.3% and 93.2%, respectively
  - The method of this paper is low in cost and high in stability

Objective

Comparitive Analysis of Heuristic Techniques for vehicle movement detection

- **We try to study different methods to solve this problem and try to compare the methods based on different evaluation metrics**

Dataset

- Data is often collected using loop detectors embedded in roadways, radar sensors, infrared sensors, or video cameras.
- Surveillance cameras in roads have been widely installed worldwide but traffic images are rarely released publicly due to copyright, privacy, and security issues
- **UA-DETRAC** is a challenging real-world multi-object detection and multi-object tracking benchmark.
- It Contains images of highway scenes and ordinary road scenes used for solving different problems in the field of ITS
- Since we have access to the DETRAC dataset, we have elected to utilize it as the primary source of data for our analysis.




Work flow

Traffic videos

Grayscaling

Noise reduction

Road Surface Segmentation

Using Flood Fill, Canny Edge Detection etc.

Lane detection

Vehicle detection and Tracking

Evaluation Metrics

Accuracy, Precison, Ground Truth

Timeline

1st Review

Understand various research works, explore the dataset and conduct basic implementations

2nd Review

Explore more research papers and implement different appraoches of our problem statement

3rd Review

Try to automate the thresholding and uncover areas for improvement.

4th Review

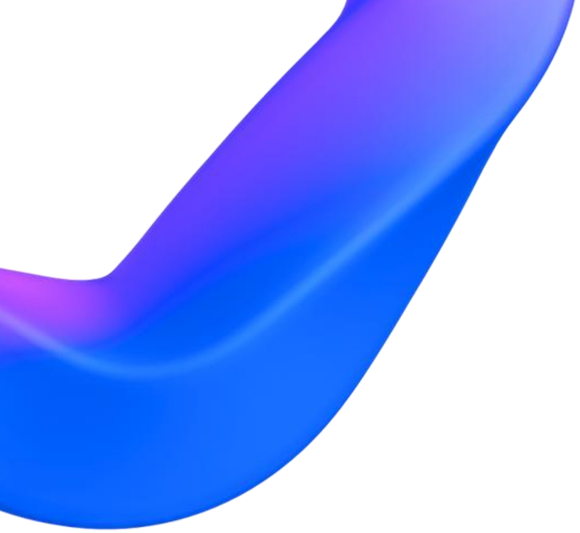
Try out the solution with traffic parameters and Document the research work

References

[1] Hadi Ghahremannezhad, Hang Shi, Chengjun Liu, “Robust Road Region Extraction in Video Under Various Illumination and Weather Conditions”, IEEE 4th International Conference on Image Processing, Applications and Systems (IPAS) pp., 2020.

[2] Sayyidul Aulia Alamsyah, Djoko Purwanto,Muhammad Attamimi, “Lane Detection Using Edge Detection and Spatio-Temporal Incremental Clustering”, International Seminar on Intelligent Technology and Its Applications (ISITIA)pp. ,2021.

[3] Huansheng Song, Haoxiang Liang* , Huaiyu Li, Zhe Dai and Xu Yun, “Vision-based vehicle detection and counting system using deep learning in highway scenes”, European Transport Research Review, SpringerOpen, pp., 2019.



Thank you