INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

HYDERABAD

Vehicle Counting Method Based on Digital Image Processing Algorithms

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COURSE CODE: DIGITAL IMAGE PROCESSING - CS7.404.M21

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Abstract: The vehicle counting procedure offers accurate data on traffic flow, vehicle collisions, and traffic peak times on highways. Using digital image processing technologies on traffic camera video outputs is an acceptable strategy for achieving these goals. The Kalman filter is used to create a vehicle counter-classifier based on a mixture of video-image processing methods such as object detection, edge detection, frame distinction, and the Kalman filter. The proposed technique has been implemented using the Python programming language. The method's accuracy in vehicle counts and classification was assessed, yielding a classification accuracy of around 95% and a vehicle detection target error of about 4%. Vehicle Counting, Vehicle Detection, Traffic Analysis, Object Detection, Video-Image Processing are some of the terms used in this paper.

1. Project Objective

This project is merely a reproduction of this paper [1], where namely two methods are suggested for designing a **vehicle-counter classifier**, i.e., "Frame Differentiation" and "Edge Detection" algorithms, to improve vehicle detection quality and accuracy. Further, they have introduced the "Kalman filter" to estimate and track the position of each vehicle accurately and sort them into distinct groups whose counts are kept for traffic flow studies. Plus, we have planned to use datasets from different open sources and check for the model performances on the same. If possible, we'll further try out vehicle-classification models to see if we can beat the benchmark.

2. Project Description

2.1. Problem Statement

The aim is to design a **vehicle counter-classifier** using a combination of different video-image processing methods including object detection, edge detection, frame differentiation, and the Kalman filter. Using this useful information one can execute better traffic management methods, such as changing the timings of traffic lights based on traffic flow. We'll mainly focus on vehicle detection on roadways and classify the passing vehicles in different specific types.

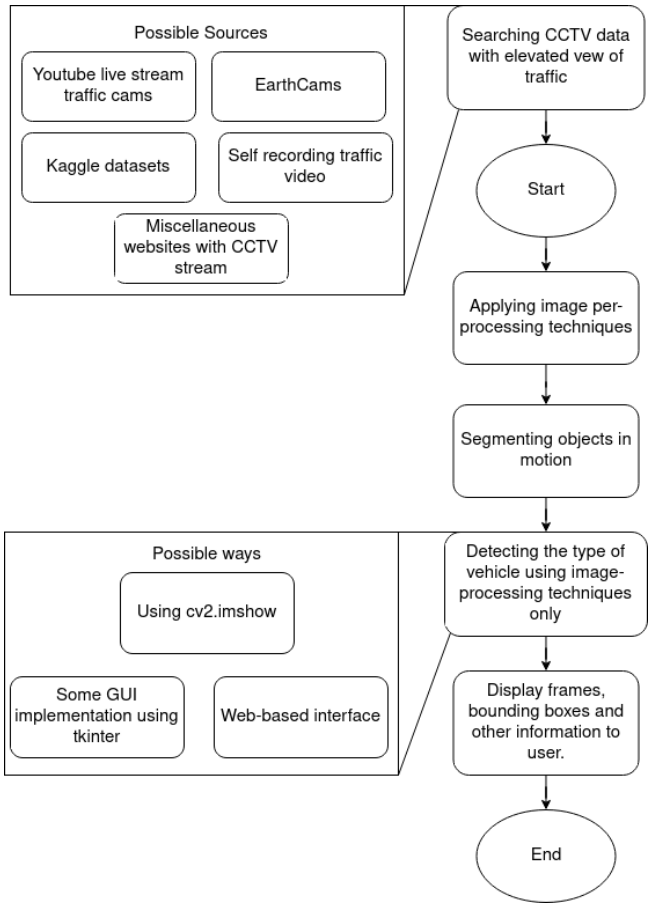

Figure 1: A sample from the available dataset

2.2. Sections Overview

1. **An introduction to Vehicle counting**: Due to the fast-growing number of vehicles, traffic problems are common nowadays and hence need to be supervised. One main component is the traffic flow analysis that can be useful for identifying critical flow time periods or determining the influence of large vehicles or pedestrians on vehicular traffic flow and even documenting the traffic volume trends. One such method is image processing and machine vision algorithms for roads/highway traffic analysis that neither requires the placement of sensor objects in the roadways nor direct camera control by humans is needed. In these

detectors, video feeds of moving automobiles on the highway from cameras positioned alongside highways are used to create an appropriate description of the situation.

We will concentrate on a **software-based** new technique for detecting automobiles on roadways and classifying them into different classes. This approach recognizes automobiles in the input video stream, assigns each one unique identity, groups each vehicle into its own separate vehicle-type group, and ultimately counts them all. And according to the given research article [1], the developed method was applied in a software platform, resulting in a lower error rate and higher accuracy.

2. **Data Analysis and Preprocessing**: This step is required so that to remove the redundancy of duplicate questions present in other records as well as eliminate irrelevant characters. For more details please refer to the "Data Overview" part of the "Project Deliverable" section of this document.

3. **Video Processing**: It uses image processing technologies in each video frame that uses video streams as input and output signals. And hence one of the greatest approaches to achieve video analysis goals on computers. Components, namely, motion creation by simply comparing successive pictures, applying pre-filters, which can induce contrast adjustments and noise reduction, as well as video frame pixel size conversions, are all part of video processing. Further, it's not only limited to the above-mentioned strategies but also can be used to highlight specific regions of videos, remove undesirable lighting effects, eliminate camera motions, and remove edge artifacts. Below mentioned are some of the techniques which we'll be implementing in this project.

4. **Background info**:
   (a) **RGB to Gray-scale conversion** as gray-scale images can provide more acceptable results.
   (b) **Power Law transforms** methods for enhancing images to provide better contrast and a more detailed image.
   (c) **Edge detection** techniques for object detection, e.g., Sobel Filter.
   (d) **The Kalman Filter** model provides improved estimates based on a series of noisy estimates and classifies the detected vehicles in different specified groups and counts them separately.

5. **Discussion and Analysis** of above methods and scope for improvements.

6. **Conclusion**

3. Project Deliverables

3.1. Data Overview:

The data is take from a highway cams in the form of video It is necessary to say that some assumptions made in this work:

- Unidirectional flow of traffic.
- No car accidents and crashes are expected
- There are both physical and legal limitations for vehicles
- Motion scenes are captured with a view from above to the roadway surface

We will try to collect such data from different sources such as highway-overhead cameras, google live-stream cams, EarthCams, etc.

3.2. Data Pre-processing

1. **Grayscale Image Generation and Image Enhancement:** The video feed will be converted to grayscale as the proposed method is on dependent on the color data so we would convert it to Grayscale after that we will enhance the image so as to make the edge detection more robust for that we will be doing contrast stretching using gamma transform with a gamma value of around 1.2.

2. **Edge Detection:** This will help us to get the bounding boxes for the vehicles. For this we would be using a 3x3 sobel filter with thresholding which would yield a binary Image that would be used to do background subtraction and detect the moving vehicles.

3. **Background Segmentation:** Edges essentially separate regions which are static regions (the roadway) and dynamic regions (moving vehicles). The static background is then subtracted to locate moving objects in each frame. The resulting zone leaves only vehicles and some details as moving objects in sequential images which are changing frame to frame. A combination of forward and backward image difference method and Sobel edge detector has been used for this work.

4. **Detection Zone:** A cropped region should be specified for execution of our algorithm. This detection zone area can accommodate both short and long vehicles, and the major purpose of defining it is to minimise perspective issues and incorrect type counts.

5. **Kalman Filter:** The measurement variables are employed as input signals based on the statistical characteristics of the system noise and measurement noise, and the estimation variables are based on the trajectory equations. This filter will be used to minimise detection noise and more precisely anticipate the path.

4. Work Distribution

Sl. No.	Task	Assigned to
1	Data Selection and Collection	Aditya, Bhoomendra, Dhruv, Prateek
2	**Image Processing** Thresholding methods and Tuning Edge Detection Motion Detection and analytis Vehicle Segmentation	 Aditya, Bhoomendra Dhruv, Prateek Aditya, Bhoomendra Dhruv, Prateek
3	Kalman Filtering	Aditya, Dhruv
4	Vehicle Classification	Bhoomendra, Prateek
5	Possible Improvements	Aditya, Bhoomendra, Dhruv, Prateek

5. Timeline

Sl. No.	Milestone	Deliverables	Timeline
1	Project Proposal Submission		9^{th} November 2021
2	Video Pre-processing	Thresholding Detection Segmentation	16^{th} November 2021
3	Vehicle Classification	Kalman Filtering	25^{th} November 2021
		Other Methods	27^{th} November 2021
4	Result Compilation		29^{th} November 2021
5	Final Presentation	Project Presentation	1^{st} - 4^{th} December 2021
6	Final Submission		4^{th} December 2021

References

[1] Ali Tourani and Asadollah Shahbahrami. Vehicle counting method based on digital image processing algorithms. In *2015 2nd International Conference on Pattern Recognition and Image Analysis (IPRIA)*, pages 1–6, 2015.