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Study of Video-based Traffic Optimization using Image Processing

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Abstract

In this study, we have investigated the prospects of predicting traffic based on video surveillance. We have used the following image processing algorithms: object detection and counting it, pathway analysis. The process is designed to analyze images obtained from a surveillance camera. The model uses server-client architecture.

Keywords: Surveillance, Image Processing, Traffic

I. INTRODUCTION

The emergence and development of various advancements in transport analytics are associated with an exponentially increasing number of vehicles on roads, which leads to a noteworthy increase in economic and social costs. Inadequate traffic safety and traffic jams are significant issues in cities around the globe. A solution to this issue is not economical in the face of increasing load on transport infrastructure.

However, traffic control systems nowadays all share an underlying limitation, that they cannot predict anything. Knowing real-time traffic conditions is an important aspect to help drivers avoid traffic jams.

One possible approach is the application of adjusting traffic control systems placed in the streets of a city. The traffic control systems not only reduce time delay and hindrance but also solve other problems:

- Identification of accidents and vehicles stopped in inappropriate places.
- Compliance monitoring and registration of traffic infractions.
- Getting traffic flow statistics.

The footage from the cameras is divided into frames. The frames are converted into gray frames and then given as an input to the system. Then a particular region is selected as a region of interest, the vehicle is detected in that region. The vehicle is tracked till it remains in the region. Each frame is compared with the preceding frame; if the car is present in more than one frame and the difference in the x and y coordinates is not much, then we will consider it as the exact vehicle. If the difference is more, then we think of it as a different vehicle.

II. LITERATURE REVIEW

- A model and genetic algorithm for area-wide intersection signal optimization under user equilibrium traffic. [1]
- Feedback-based Traffic Light Control. [2]
- A self-adaptive evolutionary algorithm for dynamic vehicle routing problems with traffic congestion. [3]
- Adaptive traffic signal control with actor-critic methods in a real-world traffic network with different traffic disruption events. [4]
- Dynamic traffic routing in a network with adaptive signal control. [5]
- Study Of Automatic Traffic Signal System for Chandigarh. [6]
- Intelligent Traffic Light and Density Control using IR Sensors and Microcontroller. [7]
- Real-Time Traffic Density Count Using Image Processing. [8]

III. METHODOLOGY

A. *Car Detection and Counting*

The block diagram given below correctly describes the working of our system.

Fig. 1: Algorithm Flow

1) Input Frames: Input to The System
2) Vehicle Detection
3) Selection of Region of Interest
4) Vehicle Tracking
5) Vehicle Counting

1) Input Frames

The system gets input from the surveillance footage and is divided into frames. Those frames are then converted into grayscale and are given as input to the system.

2) Vehicle Detection

We used Background subtraction tools to detect the background and trained our application for the first 500 frames, to detect the best and the most reliable background. The algorithm takes background pixels and assigns a Gaussian Distribution to each one of them. The weight of this distribution is the period the colors stay the same in the scene. The algorithm tries to differentiate the background and foreground by the information from the Gaussian mixture. The idea is that the longer the color stays high, the probability of the color being a part of the background. When applied to the first frame provided, it starts creating a background model. Further, when frames are fed to, it continues updating the background. Then we make some processing for image quality like opening, closing, dilation, erosion, and blur to draw our contours perfectly, after that thresholding the detected contours to extract the best ones and count them as moving vehicles.

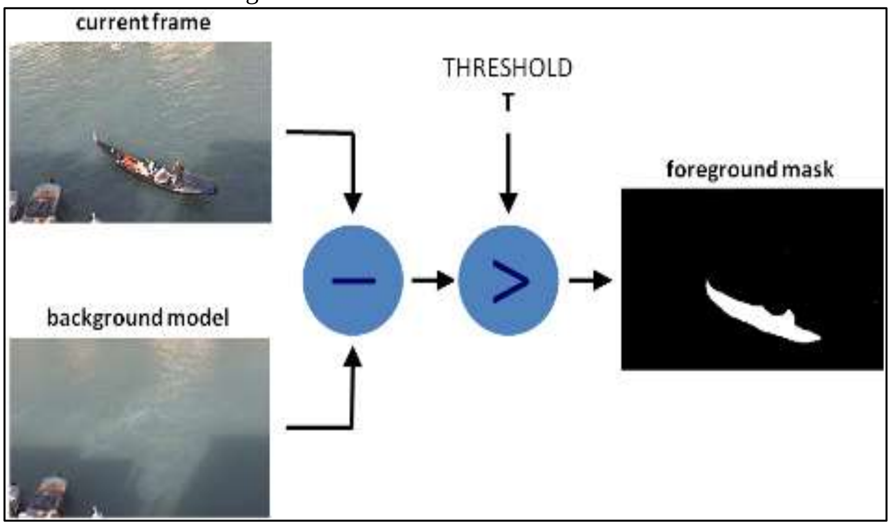

Fig. 2: Object Detection

3) Selection of Region of Interest

A region of interest is a specific region of an image that is considered important in this study in obtaining data.

4) Object Tracking

Vehicle tracking was used to obtain the position of a vehicle in the frame to be compared with the list of previous tracked positions of vehicles; however, new positions or positions not including that on the list of tracked vehicle positions were added as a position (x, y) of a new vehicle. If the new position was included in the list of positions of previously tracked vehicles, it would be used as a new position of a recognized object. Vehicle tracking is composed of finding the detected vehicle continuously in a video. The process is done by marking the boundary around the detected vehicle.

5) Object Counting

Every passing vehicle inside the Region of Interest is tracked based on its position and would be compared with the list of tracked vehicle positions. For a new position or position not included in the list of tracked objects, it was added as a new vehicle and should be counted. If the new position was included in the list of positions of previously tracked vehicles, it means the position had already been counted as a recognized vehicle.

B. Server-Client Architecture

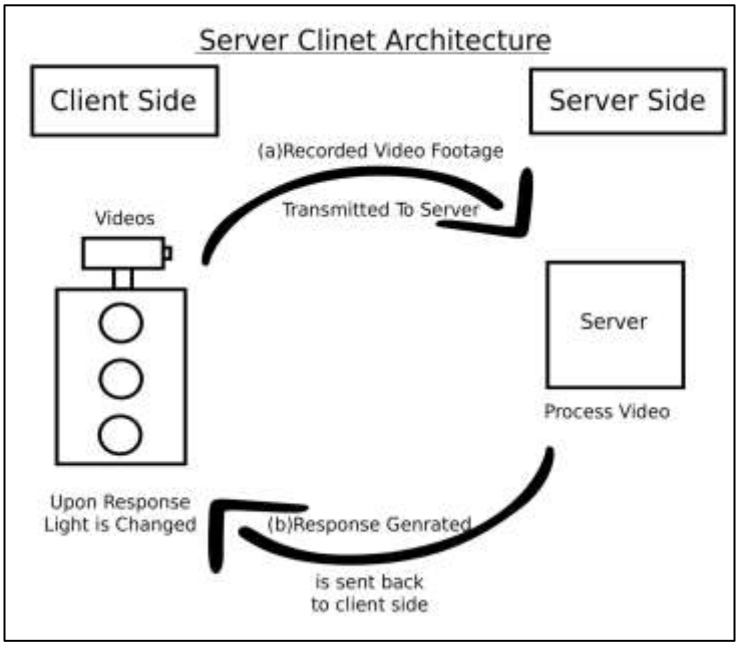

Figure 1 Server Client Architecture

Here, we have traffic lights equipped with intelligent cameras acting as clients and a traffic control center serving as a server.

The videos are sent unprocessed to the server from traffic light cameras, i.e., our client. After that car detection algorithm processes, the video and the specific response based on the condition are sent back to the client.

The response is calculated using the following code.

```
if q==0 and x==0:
    return min_waited_time
 ratio=q/(q+x)
 waited_time=ratio*max_waited_time
 if waited_time < min_waited_time :
    waited_time = min_waited_time
 elif waited_time > max_waited_time :
    waited_time = max_waited_time
 return int(waited_time-(waited_time%5))
```

IV. DIFFERENT TECHNIQUES AND ALGORITHMS

A. Color to GrayScale

cvtColor() is used to transform color images to grayscale. This function is inbuilt in the python library Open-CV.

B. Dilation

In Dilation we expand the image. In this, we add several pixels to the boundaries of objects in the image.

C. Erosion

Here, the area of the dark region grows, and bright regions decrease in size. i.e., the size of an object in dark shade or black shade increases, while that in the white shade or bright shade decreases.

D. Canny Edge Detection

Used to detect the edges in an image. Then the borders are represented with different colors.

V. RESULTS

Here, we can identify the objects and draw the boundaries around them. Then with the help of those boundaries, we can count the total number of objects.

Then we are successfully able to alter the timing of signals based on the number of vehicles that are on each side of the traffic signal thus minimizing the problem of congestion.

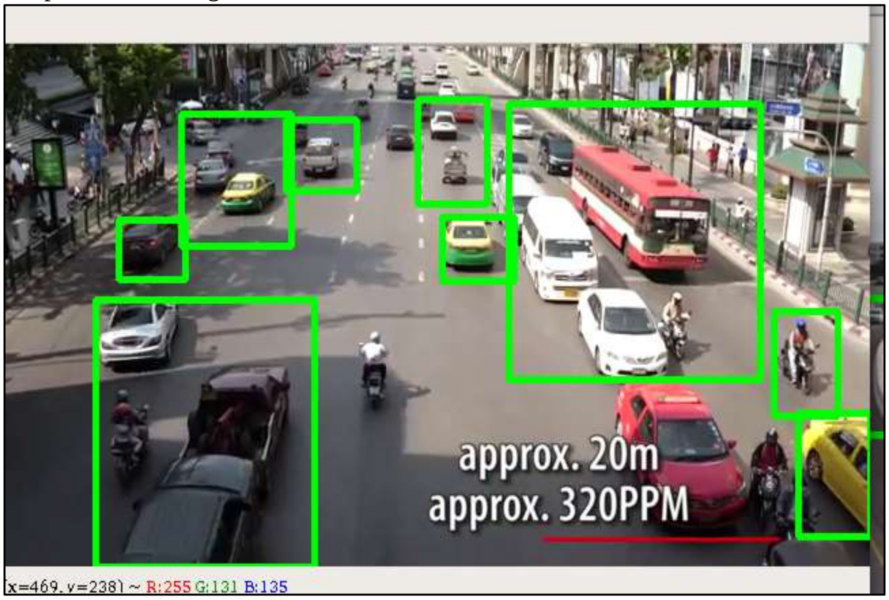

Fig. 2: Object Detection Example

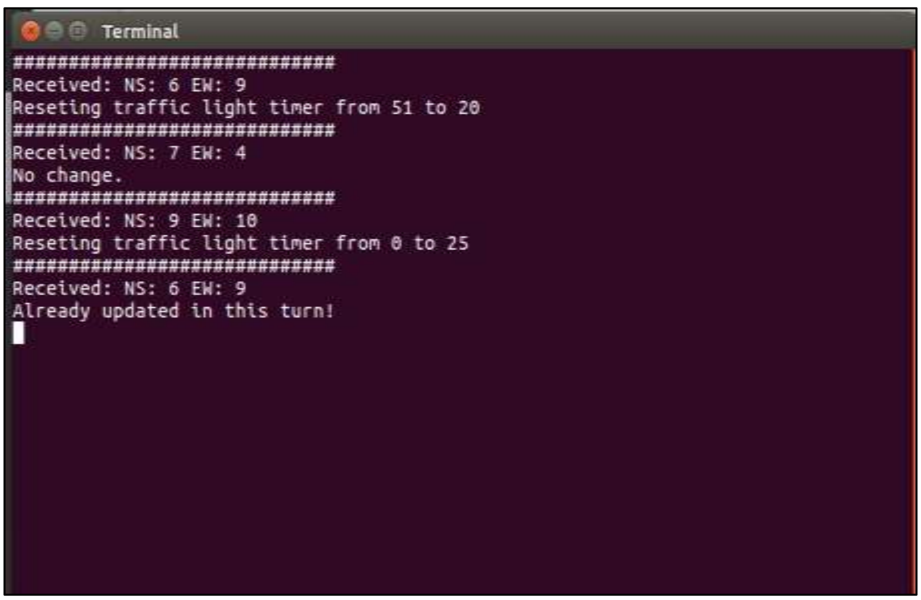

Fig. 3: Response Sent to the Client

Here, response is sent through the socket framework where server runs on node and client on different node.

VI. CONCLUSION AND FUTURE SCOPE

With the continued increase in the automobile industry and congestion on the roads due to increasing car density. Our work can help to manage this traffic and provide a systematic way to organize congestion across the globe.

The idea we are presenting has certain limitations like it is not that much cost-effective and it is difficult to operate during the night as object detection does not work as expected without proper lighting.

Further, with help of our work different technologies and innovation can be involved to improve the system. As, it will be beneficial to make traffic control fully automatic.

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