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Smart Traffic Control System

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Abstract— Machine learning is a field of computer science that gives computers the ability to learn without being explicitly programmed. The objective of this paper was to propose a machine learning based approach to monitor traffic signals. The proposed approach helped to detect and recognize different types of vehicles and calculate traffic density in a given frame. The vehicle density measurement is done by measuring the number of pixels of the detected vehicles and then simply taking the ratio of the measured pixels to the total number of pixels that the road incorporates.
This approach compares the available image with a set of standard images. The dataset of standard images has different images for different type of traffic density. After the comparison of the two the density is determined, according to which the traffic lights are controlled.
This approach uses modern computing techniques such as machine learning algorithms using libraries such as openCV and HAAR cascading.

1.Introduction

One of the biggest problems in the urban areas is the ever increasing traffic congestion. Modern technology makes it easier for us to tackle this problem and hence the need of introducing these techniques in traffic control. The ever growing number of vehicles continuously adds to this problem and the current infrastructures or the current methodologies are not sufficient to tackle this problem. The two most commonly used methods are, first, using timers in each phase and the second, using electronic sensors that detect automobiles and produce a signal which cycles. Since these methods are not sufficient in themselves we propose a system that utilizes image processing techniques to control the traffic light. The system detects vehicles with the help of images captured by a camera instead of using electronic sensors. The camera will be installed alongside the traffic light. There are many technologies but they have their limitations. For example:

R-CNN and its variants do not employ sliding window protocols like many other object recognition algorithms rather they make use of regional proposals. This is quite a complex process as it involves various steps such as generation of potential bounding boxes, extraction of features using a convolutional neural network, after which a support vector machine scores the boxes, the bounding boxes are then adjusted by a linear model, and finally duplicate detections are eliminated by the use non-max suppression. As evident from this process each step must be tuned precisely which in turn compensates the time factor, taking more than 40 seconds per image at test time.

YOLO is another technology that shares some similarities with R-CNN. Here, each grid cell creates its own bounding boxes and then those boxes are scored using convolutional features.

Fast and Faster R-CNN are technologies that focus on speeding up the R-CNN. Even though these algorithms improve the speed and accuracy of the framework they still do not ensure real time performance.

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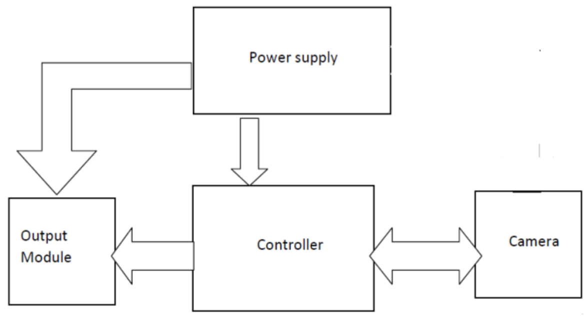
2.Block Diagram



Camera: - We use cameras that are installed on roads for traffic surveillance. The image quality is of less importance as compared to the execution time and hence images can be of lower resolution and therefore the usage of better cameras is not required.

Power supply:-A 230v, 50 Hz AC input will be taken as input. The output will be the DC voltage required for the working of controller, camera and signal.

I/O Module: - The I/O module consists of the traffic signals that are to be controlled. We have used 3 different colored LED lights to emulate the traffic signal lights.

Controller: - For the training of the module a GPU is required. We have used an NVIDIA GeForce 940 mx GPU to train our model as using a powerful GPU speeds up the training process.
A raspberry pi controller is used which houses the LED and the camera modules necessary for simulating the project.

3.Model training

A.HAAR cascading

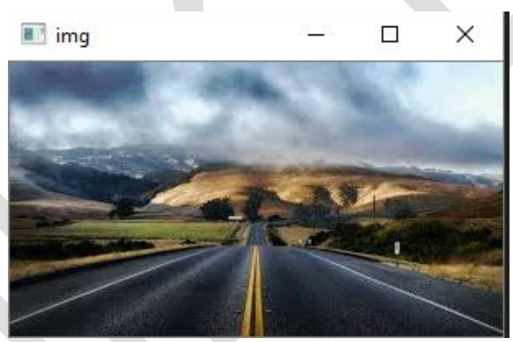
The training of the model utilizes two different sets of images i.e. negative and positive images sets. These images samples serve as directives for the model the set of positive samples contains actual objects you want to detect and the set of negative images contains everything you do not want to detect. In this particular case, negative images can be the background (trees, humans, animals, other structures etc.).
The opencv_createsamples application is used to create positive images. The boosting process utilizes these to direct what the model should actually look for when trying to find your objects of interest.

Figure 1: Positive images used to train the model.

B.Experimenting

We experimented on different images using various pre- trained models. The results are as follows:

This is a sample image that was used to test the accuracy of the model and the time required for the execution. Since this is a real time application the execution time of the application is of the utmost importance.



The given image has no car present in it and hence no object is detected. As we have trained the model to classify the background objects such as trees and road as negative images it simply ignores them.

Pixel measurement

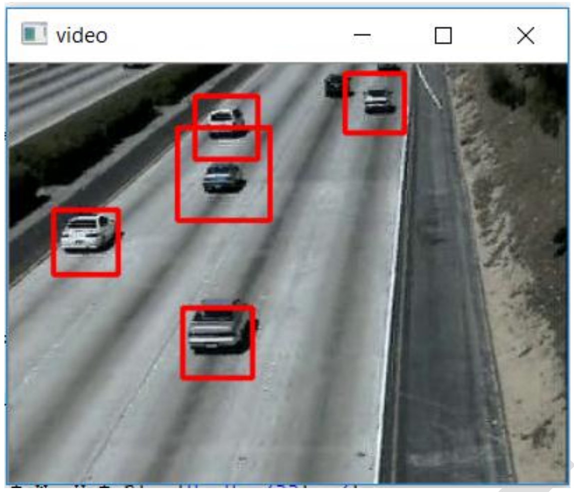
Dimensions: (330, 153) Total pixels: 50490

We have written a simple script in Python that takes the processes the frame and calculates the total number of pixels in the image.

The number of pixels is used in measuring the pixel density which in turn is used in measuring the traffic density on the road.

4. Implementation

During the actual implementation phase we took live video feed and detected vehicles directly from the video stream.



As seen from the two images the vehicles are detected and all other objects in the background are neglected. Also comparing the first and the second image we see that the cars are not detected right away but after some time. This is due to requirement of a larger processing time and this serves as a limitation of this approach.

5.Acknowledgment

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6.Conclusion

We have thus successfully implemented our model which aims to regulate traffic lights through the use of machine learning in conjunction with image processing. Although, we have implemented only one application, the model which lies at its heart can be further used, with little modifications, in different applications which require image classification and real time decision making.

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