IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 1, December 2022

Density based Intelligent Traffic Light Control using Image Processing

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Abstract: *Increasing traffic congestion is a constant source of frustration, time loss, and expense to users and managers of transportation systems. Traffic is the serious issue which each nation faces due to the expansion in number of vehicles. One of the strategies to beat the traffic issue is to build up a smart traffic control framework which depends on computing the traffic density and about utilizing constant video and picture preparing procedures. The topic is to control the traffic by deciding the traffic density on each roadside and control the traffic signal smartly by utilizing the density data. In this paper, an automated system based on processing of real time videos is proposed for detection of vehicles and recording count of them. The System will consist of various stages which includes Object Car Detection and Signal variation based on density. Captured video will be converted into frames and which will be pre-processed. The density count algorithm works by contrasting the ongoing edge of live video by the reference picture and via looking through vehicles Just in the district of intrigue (for example street region).*

Keywords: Traffic Congestion

I. INTRODUCTION

Traffic clogging has become a difficult issue in urban areas. Traffic congestion has long been recognized as an economic and social impediment worldwide having a detrimental effect on human productivity, air quality, fuel usage and overall quality of life. Increasing traffic congestion is a constant source of frustration, time loss, and expense to users and managers of transportation systems. Cities, countries, and state transportation agencies are persistently searching for ways to mitigate urban traffic congestion, while minimizing costs and maintenance requirements. The congestion and delays that characterize much of the region's transportation system have also intensified other social and environmental problems such as productivity losses, wasted energy, degraded air quality, and increased vehicular accidents. In future, for the overall development of the country it is important that infrastructure, of which road traffic is a very important part, should be made state-of-the-art. This makes the study very valid in the present conditions. The problem of traffic is a complex one requiring design, planning, engineering and institutional inputs for developing a proper solution. In urban areas, traffic signals are the limiting factors and common congestion points. Therefore, controlling traffic congestion relies on having an efficient and well-managed traffic signal control policy. There is no doubt that signals are one of the most powerful tools for urban traffic control available to city authorities and their correct installation can improve both traffic flow and the safety of all road users.. The problem can be solved by using present emergent technologies like IOT and image processing. A large amount of research is going on in these fields. In our proposed system we have made use of these technologies in order to develop a smart and intelligent traffic control system. Both of the methods individually have their own drawbacks individually.

II. REVIEW OF LITERATURE

2.1 Study of Research Paper

- Adil Hilmani , Abderrahim Maizate, and Larbi Hassouni, Automated RealTime Intelligent Traffic Control System for Smart Cities Using Wireless Sensor Networks, Wireless Communications and Mobile Computing Volume 2020.
- Duy Nhat Nguyen, Adaptive Traffic Control System: Design And Simulation, Concordia University, July 2015

- Peng Jing, Hao Huang and Long Chen, An Adaptive Traffic Signal Control in a Connected Vehicle Environment: A Systematic Review, School of Automotive and Traffic Engineering, Jiangsu University, 22 August 2017
- MADHUKAR, Adaptive Traffic Signal Control Using Fuzzy Logic, IJCRT — Volume 6, Issue 2 April 2020
- Hong K. Lo H. E Chow, ―Adaptive Resolution, and Accuracy, March 2002; Accepted: July 2002

III. PROBLEM STATEMENT

Signals are allocated a fixed time and according to that time it will work but the problem here is even if there are no vehicles in that lane the signal will turn green according to the fixed timer statically allocated to it without any cause. So propose a system in which signal lights will be manipulated according to the density of the vehicles in that particular lane. The lane which has a greater number of vehicles will be given a preference. We are trying to substitute the whole system into video processing.

IV. PROPOSED SYSTEM

Proposed system is shown in figure 1 and explanation is given below.

4.1 Image Acquisition

The system starts with an image acquisition process in which the live video is taken and processed by camera, mounted on the signal stand. The video is captured lane wise, the camera shifts from one lane to another after a specific time interval.

4.2 Image Cropping

The frames from the video are extracted which are processed further. The second step is the image cropping in which the focus is on region where the vehicles are present and are surrounded by noise and other data.

4.3 RGB to Grayscale Transformation

RGB Images contains lot of data and it takes time for processing, to minimize this processing time the RGB color images are converted to gray scale and passed to next stages. The equation for rgb to gray scale conversion is given below:

$$Gray=0.2989 * R + 0.5870 * G + 0.1140 * B$$

4.4 Threshold

Threshold is used for classifying the pixel values in an image which is done on grayscale images, which are images which have pixel values. When you threshold an image you classify these pixels into groups setting a upper and lower bound to each group. Threshold can be performed by local methods as well as by global methods, Threshold is one of the methods which is used to suppress the background and obtain a clear foreground. In this paper Otsu's Threshold is applied, it converts the gray scale image to binary form based on the selected threshold value.

4.5 Contour

The binaries image obtain from threshold stage is passed to the contour step to define the contour for the detected objects. Contours can be clarified as basically as a curve joining to every single continuous point having same shade or intensity. The contours are helpful to object detection and recognition.

4.6 Calculate Traffic Density

In this we calculate the density of the number of vehicles present in the lanes by the camera using cv2 algorithm, which helps to decide the changing of the signal color thus managing the traffic. The input video provided to the system will be checked and the frames will be extracted from it. The noise and other simplifying objects like shadows will be filtered out. The conversion of the extracted frames from rgb to grayscale will be done. After this the contours on the frames will be detected and the object will be successfully detected using cv2 algorithm.

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4.7 Conventional Traffic Control System Manual Controlling

Manual controlling refers to manual adherence for monitoring and controlling the traffic at the signals. Contingent upon the nations and states the traffic polices are allotted for a necessary region or city to control traffic. They are told to wear explicit garbs so as to control the traffic.

4.8 Automatic Controlling

The traffic lights are automated based on the sensor information and using clock timers for display. In rush hour gridlock light, each stage a steady numerical worth stacked in the clock. The lights are naturally jumping ON and OFF contingent upon the clock worth changes. The automated traffic signals make use of sensors to detect the vehicle availability and a flag is raised at each step, based on the above mechanism the lights turn ON and OFF automatically.

4.9 Hardware Specification

- Windows 7& above
- Ram :- 4 GB or More
- Hard Disk :- 500Gb&Above

4.10 Software Specification

- Tools - Python IDLE
- Programming Language – Python
- Libraries Used – OpenCV, Tensor Flow Keras

V. SYSTEM ARCHITECTURE

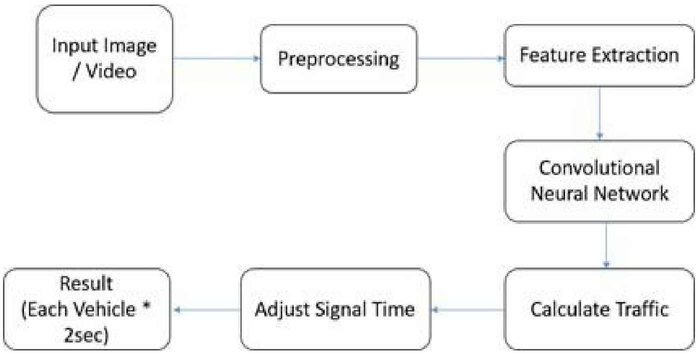

Figure 1: System Architecture

We have traffic dataset for prototype based traffic signal controlling based on vehicles is proposed in the system where we apply algorithm (CNN: - Convolutional Neural Networks). Convolutional Neural Networks is a popular deep learning technique for current visual recognition tasks.

There are four layered concepts in Convolutional Neural Networks:

- Convolution,
- ReLu,
- Pooling and
- Full Connectedness (Fully Connected Layer).

5.1 Algorithm

A. Convolutional Neural Networks

CNN or the convolutional neural network (CNN) is a class of deep learning neu- ral networks. In short think of CNN as a machine learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various as- pects/objects in the image, and be able to differentiate one from the other.

CNN works by extracting features from the images. Any CNN consists of the fol- lowing:

- The input layer which is a grayscale image

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- The Output layer which is a binary or multi-class labels
- Hidden layers consisting of convolution layers, ReLU (rectified linear unit) layers, the pooling layers, and a fully connected Neural Network

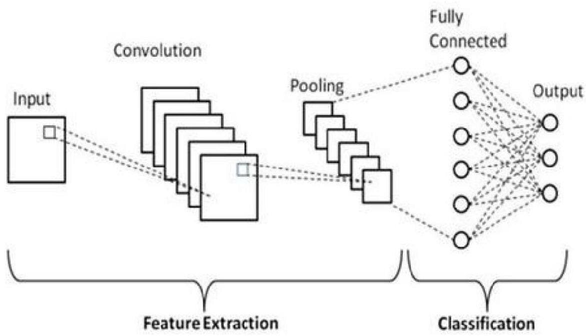


Figure 2: CNN Algorithm

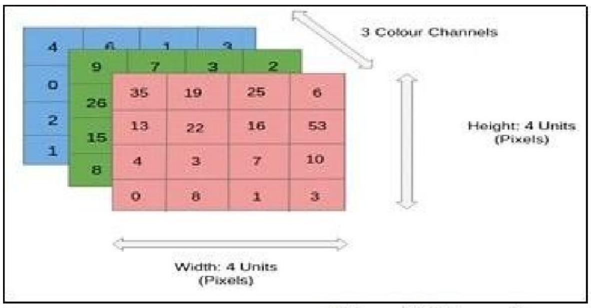
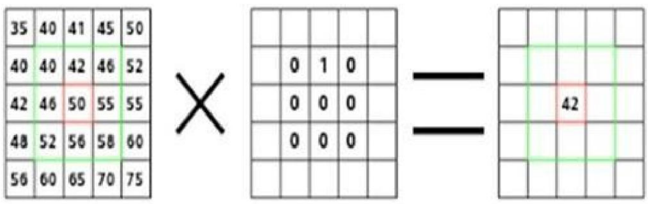


Figure: RGB image layears

The challenge with images having multiple color channels is that we have huge volumes of data to work with which makes the process computationally intensive. In other worlds think of it like a complicated process where the Neural Network or any machine learning algorithm has to work with three different data (R-G-B values in this case) to extract features of the images and classify them into their appropriate categories

VI. LAYERS OF CNN

6.1 Convolutional Layer



Convolution operation on image matrix

The general objective of the convolution operation is to extract high-level features from the image. We can always add more than one convolution layer when building the neural network, where the first Convolution Layer is responsible for capturing gradients whereas the second layer captures the edges. The addition of layers de- pends on the complexity of the image hence there are no magic numbers on how many layers to add. Note application of a 3 x 3 filter results in the original image results in a 3 x 3 convolved feature, hence to maintain the original dimension often the image is padded with values on both ends.

6.2 Pooling/Sub sampling Layer

The pooling layer applies a non-linear down-sampling on the convolved feature of- ten referred to as the activation maps. There are two types of pooling, Max Pooling that returns the maximum value from the portion of the image covered by the Pooling Kernel and the Average Pooling that averages the values covered by a Pooling Kernel.

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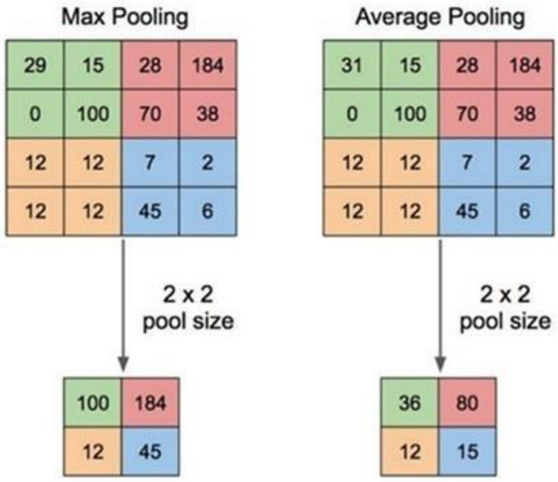


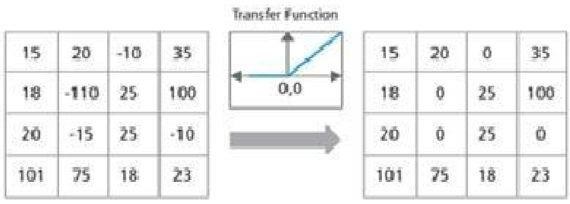
Pictorial representation of max pooling and average pooling

6.3 Non-Linear Layers

Neural networks in general and CNNs in particular rely on a non-linear ―trigger‖ function to signal distinct identification of likely features on each hidden layer. CNNs may use a variety of specific functions —such as rectified linear units (ReLUs) and continuous trigger (non-linear) functions—to efficiently implement this non-linear triggering.

6.4 ReLU

A ReLU implements the function y = max(x,0), so the input and output sizes of this layer are the same. It increases the nonlinear properties of the decision function and of the overall network without affecting the receptive fields of the convolution layer. The advantage of a ReLU is that the network trains many times faster.



Pictorial representation of ReLU functionality

6.5 Fully Connected Layers

Fully connected layers are often used as the final layers of a CNN. These layers mathematically sum a weighting of the previous layer of features, indicating the precise mix of ―ingredients‖ to determine a specific target output result.

In case of a fully connected layer, all the elements of all the features of the previous layer get used in the calculation of each element of each output feature. The fully connected layer L. Layer L-1 has two features, each of which is 2x2, i.e., has four elements. Layer L has two features, each having a single element

VII. CONCLUSION

The study showed that video processing is a good technique to control road congestion. The proposed model provides solution to the growing traffic congestion problem and can effectively replace the existing traditional methodologies or traffic control system. Depending on traffic the signal will be adjusted and the accident detection is also proposed.

The system can turned out to be very promising while implementing and testing independent components or modules based on the concept and approach we proposed.

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