Traffic Management using Convolution Neural Network

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Abstract: Traffic is one of the major problems in most of the metropolitan cities. Classifying the traffic conditions are important for determining traffic control strategies and management. Traffic congestions have negative impact on society, as a lot of time is wasted in it and controlling the congestions is necessary. By classification we can get to know which lane has traffic, from which we can further check the reasons for traffic and to take appropriate decisions to improve the performance. Video on traffic data is suitable source for traffic analysis. In this paper, video surveillance data is used for classification of road traffic using Convolution Neural Network. Convolution Neural Network requires minimal preprocessing when compared to other classification algorithms and is known for its accuracy. The video is classified based on rating of the traffic of its content. The Convolution Neural Network is first trained and then it is evaluated and updated using validation set. Once the model is completely trained it is tested with the testing set. This trained model is capable of processing the live streaming video and classifies each of the frames and gives the rating of the traffic for each lane, which can be helpful for traffic management.

Index Terms*: *convolution neural network, traffic management

I. INTRODUCTION

The Important issue is to classify the road traffic conditions for efficient control strategies and management [1].The traffic congestions degrade the quality of travelling. For efficient working of transportation system automatic traffic classifiers will be helpful, where the lanes with traffic can be given higher time for moving.

In most of the transportation systems cameras are installed for video monitoring of traffic. Through video monitoring, congestion changes are tracked and appropriate measures are taken accordingly. This video monitoring is also useful for surveillance and also in case of accidents.

Revised Manuscript Received on April 25, 2019..

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CNN is used for classification of road traffic which are efficient tools for classification. Video traffic monitoring is convenient traffic data which will be classified by CNN. CNN does the image recognition and classification. CNN is made of neurons which have learnable weights and biases. The vehicles are extracted from the image background of the video by considering each frame. Extracted vehicles are sampled by considering space and time [1].

Video is sequence of consecutive images or frames. Each image is made up of numerous pixels and are represented in matrix form with depth of three, which is RGB values and are called tensors. Tensors have dimension beyond 2D plane, which are like arrays nested within the arrays. The height and width are understood easily but the depth is necessary in case of colored images for RGB values. The image content has varying parameter which is congestion changes Using CNN [1]. A highly correlated patch of image having common features and their distribution is identified. The input for the neural networks is pixels of the images which hold some value.

CNN consists of stack of convolution layers separated by activation and pooling layers. The activation and pooling layers are called supporting layers. The layers are made of number of filters working on input frames of image. Activation and pooling layers process the result of filtering changing the resolution of output [1]. The convolution and the supporting layers together do the feature extraction task. Each layer consists of stack of neurons and each neuron is connected to the neurons of previous layer and these layers though connected to each other but works independently. The fully connected layer at the end does the classification task and the softmax layer gives the value of the congestion. Softmax layer gives rating in 0 to 10 range indicating the congestion of lanes.

The paper presents a CNN model which generates the rating for the lanes traffic which will be helpful for traffic management.

II. RELATED WORK

It is difficult to compare the results of classifier's of traffic. Because the datasets being obtained, analyzed and the performance metrics applied are varies in each work. There cannot be a single universally agreed metric in such a problem. There are many works which are carried out

on traffic management using neural networks, but the models employed are different to the one which is been presented here. A group of multilayer perceptron classifiers with error-correcting outputs is applied and results overall accuracy as 93.8%. Mean while, in another work on MLP with a particle swarm optimization algorithm is used to classify 6 labels with the accuracy of 96.9% [2].

In [3], when a vehicle passes over the stops, the induction of the wire is changed and moved. Due to change in induction, the frequency varies. This result in the electronic unit to send a notification to the controller; indicating presence of vehicles. Video frame analysis consists of a camera which is made-up of sensors, a unit of processing, communication and the traffic is monitored continuously using a camera. The captured video frames are then compressed so as to reduce the bandwidth. The video analysis extracts scene description from the raw video data. This description is later used to compute traffic data.

In [4] an entropy-based minimum description length of features as a pre-processing steps to various algorithms such as C4.5, Naïve Bayes, SVM and KNN. Declaring a quality performance of the algorithms, achieving a accuracy of 93.2% to 98%.

In [5] Intelligent traffic management system brings a plan to use RFID to manage the traffic in an intelligent manner. It explains every subsystem function. Mainly the system includes: intelligent traffic management center system or intelligent traffic command. The system can enhance the efficiency of traffic management.

In [6] Object detection plays a significant role in building intelligent vehicles and intelligent transport system. Although the topic of detection of object has been studied from long years, it is still a challenge to accurately detect objects under complex conditions. In this paper, a new convolutional neural network (CNN) model for object detection of traffic is been used, by using multi-scale local and global feature representation (MFR). The model consisted of two components: an object detection network and a region proposal network that incorporates multi-scale features and global information, namely MFR-CNN. The system is trained and can detect real-world traffic objects precisely, especially small objects and heavily occluded objects.

In [7], focus on a more specific issue in social media that concerns to extracts by considering location information as detailed traffic information. Then transformed into a machine learning problem of classification. Then employ deep neural networks to classify into traffic relevant and traffic irrelevant ones. Then a convolution neural network (CNN) technique is been used to learn the abstract features of traffic irrelevant and traffic relevant ones to get the information.

In [8] Classification of traffic conditions is an essential task for deciding traffic control strategies in Intelligent Transport System. Video traffic monitoring images are convenient and best suited source of traffic data. In this, it presents a method of classification of traffic conditions based on video surveillance data. Convolutional neural network is used to classify the video and establish measures of congestion of all the observed traffic.

III. METHODOLOGY

The objective of the algorithm is to use CNN to rate various lanes of outgoing traffic to that of incoming traffic and generate values ranging from 0 to 10 for each lane and classify them. Based on these values traffic can be easily managed by changing traffic lights accordingly. The data to the CNN is from the 3.5 high pole 360 traffic camera or from multi frame systems where camera can tilt toward the visibility of lanes. The video feed from it is converted into individual frames for CNN to be processed.

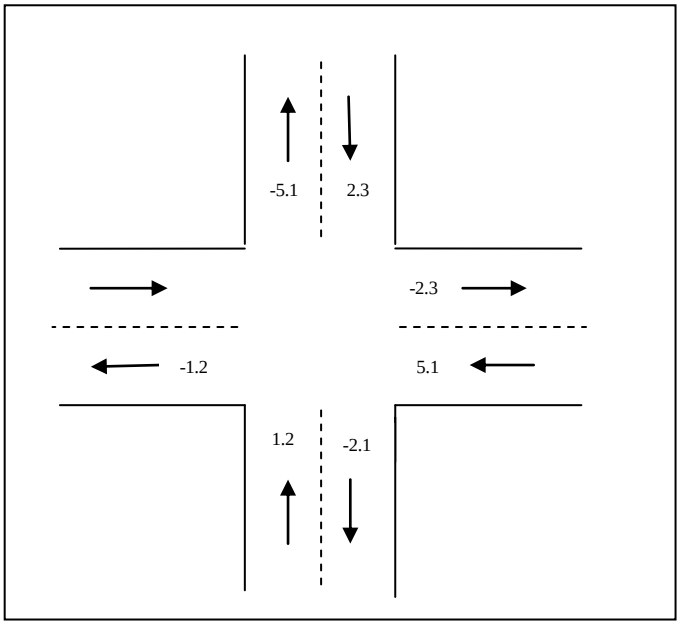

Figure 1: Rating for the lane's traffic

The important part here is to get lane ratings based on the traffic accumulated as shown in figure(1). To get this done we need to collect large dataset of frames from videos captured by traffic cameras and manually classify them based on traffic conditions.

After the collection of dataset, we need to pass it to the neural network as a training set. The CNN converts into array of pixels of three dimension(color images). The size of the array is same as the resolution of the image(height x width) times the depth of the image.

The algorithm followed by neural network is y=w*a+b, where y is the labels, w is the weights and b is the biases. For each stage, the value of w and b changes. The result generated from the classification is compared with the neighboring signals and traffic response is generated in such a way that the outgoing lanes with most traffic rating can be given greater light time and

other lanes are also managed on their rating.

The video feed is processed using openCV and the resolution is reduced from 360x480x3 to 223x223x2 at 30 frames each second. The classes for the model are not encoded and require it to be converted back to string when running the model. The output will be the value from 0 to 10.

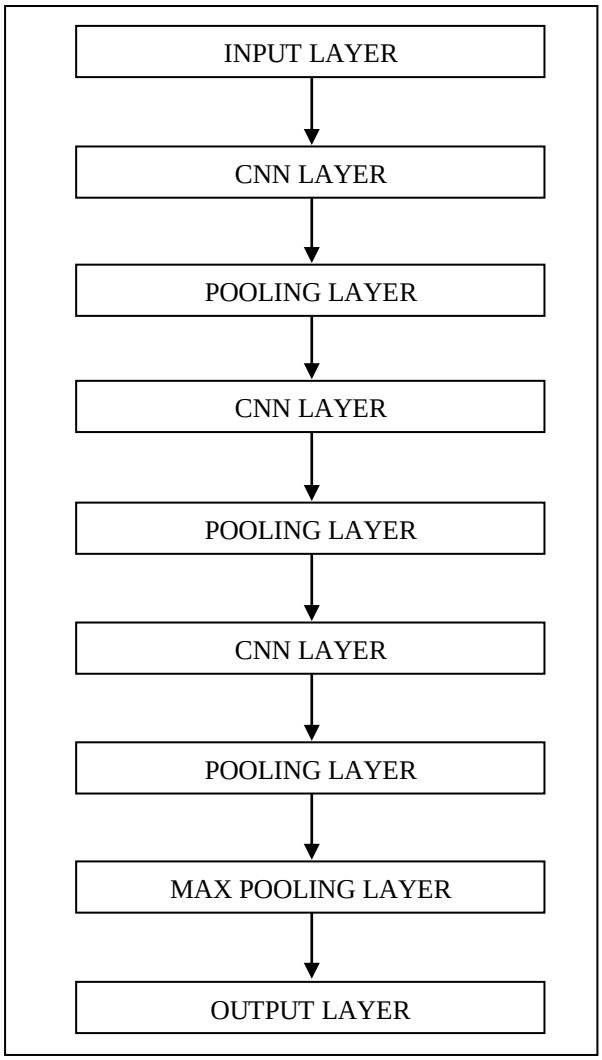

Figure 2: Layers of CNN

CNN consists of major two alternative layers which is convolution and pooling layers. These both reduce the resolution of images for processing of CNN, shown in Figure2. In each stage feature extraction is done and it produces the large feature set for original input. These feature sets helps for describing the characteristics of data. Each frame is classified and the resulting value is output on the video frame window with a traffic rating from 0 to 1.

ReLU (Rectified Linear Unit) is activation function as in Equation 1. We are applying and it is popular activation function in deep neural networks, shown below, where x is the input to the neurons.

$$f(x) = y = \max(0,x) \text{ ----------> Equation 1}$$

The activation functions that help in deciding whether a neuron will fire or not after all the weighted matrix multiplication and the addition of a bias as in Equation 2.

$$Y=W^{T}X+b \text{ ---------> Equation 2}$$

The softmax function transforms each element of a collection and output probabilities range. The range will be 0 to 1.

This will be calculated by using an Equation 3. That is, if x is a one-dimensional numpy array: softmax(x) = np.

$$F(X) = \frac{EXP(Xi)}{\sum_{j=0}^{k} EXP(Xj)} \; i = 0,1,2,.. \quad \text{\_\_\_\_\_Equation 3}$$

IV. RESULTS AND DISCUSSION

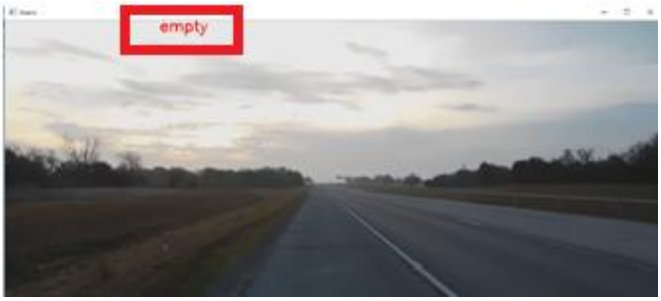

Figure 3: Output for the empty road

In the Figure 3 since there is no traffic available so the machine gives the output as empty and along with that no rating is provided as the road is completely empty.

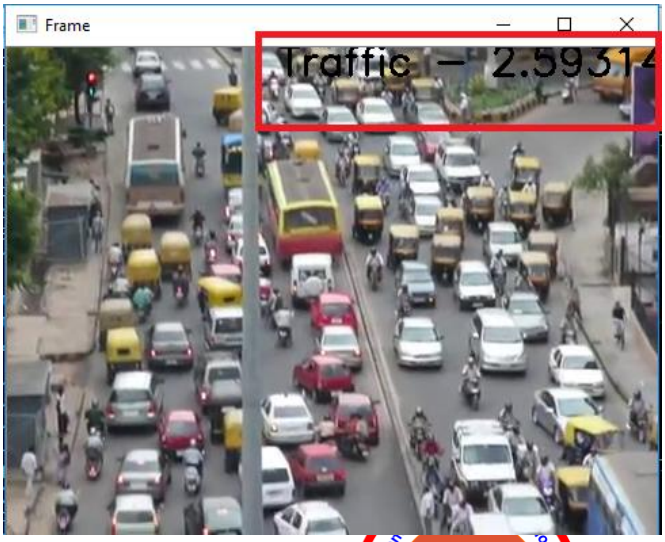

Figure 4: Output for the traffic road

Since the traffic is present in the Figure 4. So the machine has recognized and gave the output as traffic along with that rating is also provided which will in turn help in managing the traffic. The rating is between the ranges of 0 to 1.

IV. CONCLUSION AND FUTURE SCOPE

After brief research and study on our algorithm we got the accuracy of 80+N% from our machine. The algorithm will work in getting the rating of each lane within the range between 0 to 10 in order to help the traffic lights going from red to green and vice versa by detecting the condition of the road like if the lane rating is more closer to 10 than 0 it conveys the information that traffic is still present on the lane in higher density and the green light timer can be increased to let it be ON for a few more seconds or minutes (depending on road conditions) in order to get that particular lane rating low and once the lane rating becomes more closer to 0 rather than being closer to 10 the red light can be switched on and the same can be adjusted in the most efficient way which will in turn help in the efficient traffic management of the live moving traffic on the roads.

In order to make the machine learn to recognize more and more different types of vehicles and other objects on the road, more and huge training sets must be run on system which will take up a huge time and space in order to get the system trained to get the higher accuracy. Such as to train the machine for two wheeler or pedestrian crossing, we need to input more and more larger training set which consists of the required and sufficient data in them in order to train the machine to get higher accuracy. Also for each different lane a different pant tilt camera will be needed in order to capture the video of that lane and give the lane rating as single pan tilt camera will give lane rating of only single lane and to get the rating of more than one single lane from only one camera input we must install the better camera that records more than one lane at the same time but it will in turn make the coding even more complex and it will also demand higher system specifications in order to compute the rating of all the simultaneously and it will increase the cost of project a little more.

The algorithm after finishing the successful training on each type of data of dataset can be collaborated with the satellite maps available with us in the present day such as google-maps which will help a user of satellite maps to get additional information about time of the traffic light that is being used from the source to the destination with the help of which more accurate time required to each from source to destination can be calculated.

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