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Detection of Traffic Congestion from Surveillance Videos using Machine Learning Techniques

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Abstract – Smart Cities applications, automated traffic control and management is the most trending research area. With the improving needs of developed towns and cities traffic congestion, now a days this the traffic congestion control and its applications has large needed facing problem in the increased population cities. Peeled eye camera photos and videos can be watched efficiently to detect traffic congestions in most of the areas in the grown populated cities. The earlier researchers had observed more on traffic signal controls through photos executed by using different algorithms of machine learning. There is existing research available on traffic signal controls through image processing and various machine learning methods. The image features are extracted and interpreted for the same. Deep learning algorithm, convolutional neural network (CNN) is proposed for effective detection of traffic congestion. There were existing works available in traffic detection using machine learning and deep learning approaches. Machine learning, Nowadays, traffic surveillance systems collect a lot of videos or images and store them for the live monitoring purposes. Deep learning techniques are used sparingly in traffic surveillance and control systems. Various images with various weather conditions are collected and are used as training dataset. Advantages of deep learning have been exploited in many applications, which use computer vision and image analysis. One of such applications is traffic monitoring, in which large amounts of video or images are processed for effective learning. The traffic surveillance can only monitor, which cannot detect the traffic on particular time.

KeyWords: *Machine learning, deep learning, Convolution Neural Networks (CNN) Traffic prediction, and multi-class classification***.**

I. INTRODUCTION

Existing techniques used video detection and other hardware equipment for detecting the traffic. Thus, the cost of implementation and maintenance of traditional systems were high. Video transmission and traffic computation cost is high in the traditional systems. Improvements to the deep learning process have appeared in a variety of real-world applications, including traffic monitoring. Deep learning models make image analysis and traffic detection simple. Traffic monitoring can be done with the help of spatiotemporal data. With this monitoring system, the area of traffic congestion can be seen automatically. Traditional surveillance systems are tedious as it requires huge man power and frame wise monitoring in all the surveillance cameras are required. (Frame by frame monitoring in all surveillance cameras are required). Thus, the objective of our proposed system is to develop an intelligent surveillance system, which can automatically categorize the traffic congestion as

1. High traffic, 2. Less traffic, 3. Fire accident 4. Accident.

The proposed system is considered as multi class classification and this can be achieved by Convolutional Neural Networks (CNN). , the detection of fire accidents and normal traffic accidents can be detected , in this work it takes all 4 classified images into one dataset after that it can classify these 4 types of images filtered to prepare a Trained dataset.

The image features are extracted and interpreted for the same by using CNN model and it is proposed **for effective detection** of traffic congestion. There were existing works available in traffic detection using machine learning and deep learning approaches. Machine learning, Nowadays, traffic surveillance systems collect a lot of videos or images and store them for the live monitoring purposes. Deep learning techniques are used sparingly in traffic surveillance and control systems. Various images with various weather conditions are collected and are used as training dataset. Advantages of deep learning have been exploited in many applications, which use computer vision and image analysis. One of such applications is traffic monitoring, in which large amounts of video or images are processed for effective learning. The traffic surveillance can only monitor, which cannot detect the traffic on particular time.

Normal surveillance of traffic is handled manually, which requires huge manpower to handle. It also lacks efficiency. It is a highly complex system to monitor manually and identify traffic. Moreover, human error may occur, as it is not possible to watch all cameras under surveillance. Thus, the effective monitoring of large-scale surveillance systems with an automated monitoring for traffic congestion is needed for the intelligent transport system (ITS)

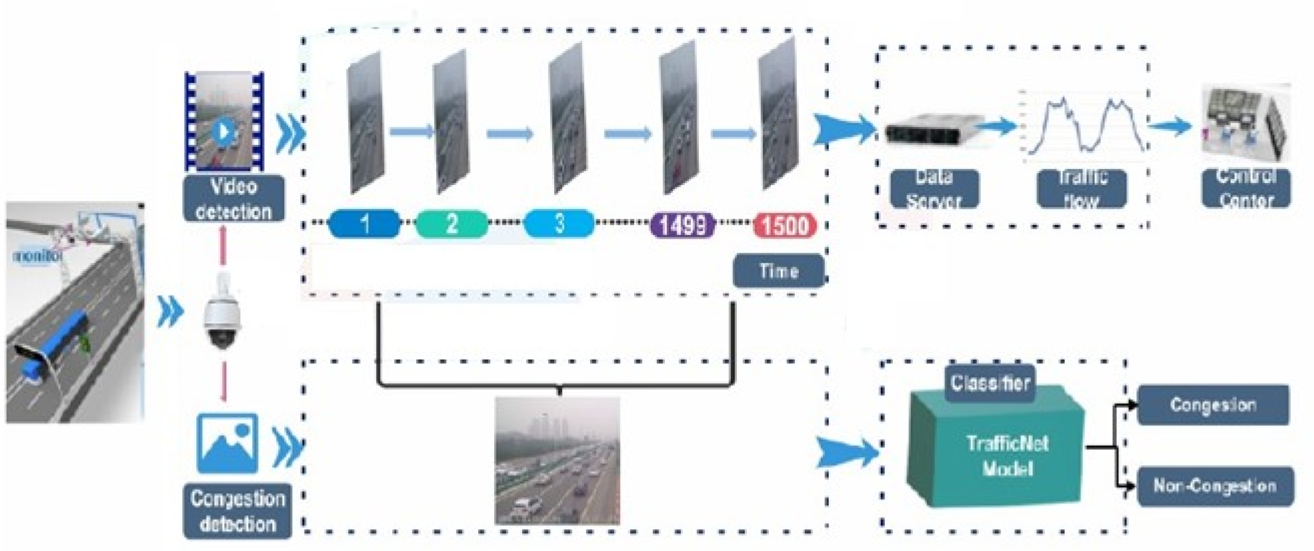

FIGURE 1: OVERALL TRAFFIC DETECTION FROM SURVEILLANCE

Which in turn is required for building smart cities in the nation. Approach, K-nearest neighbor (KNN) and Support vector machine (SVM) were used for image classification. As the traffic images are highly complex to classify, a better performance algorithm is required. The proposed system is an intelligent based traffic detection system, which can classify as dense or less traffic from the input image frames taken from surveillance videos. The deep learning algorithm CNN, which was used here, solved the problems of traditional machine learning methods. As a regional traffic congestion detection, this can be implemented as a large-scale surveillance system, which can be effectively used for smart cities. The proposed system is considered a multi- class problem, in **that** identifies high or low traffic, accidents or fire. The following segments discuss the existing work researched on traffic detection in segment 2, implementation of CNN algorithm for traffic prediction in 3. In segment 4, experimental results were discussed. In segment 5, work conclusion and future extensions were discussed.

II. RELATED WORK

Many researchers have studied traffic detection based on machine learning and deep learning models. Some of them are discussed below. Traffic classification based on Convolution Neural networks was studied [1], in this work; the author classified input images as LOS (Level of service) as four different types of LOS. This Level 1 to level 4 is traffic from low to high representation. The system analyzed the vehicle number or density on the road for classifying it as LOS 1 to 4. The author compared the proposed work with multi-layer perception and Deep learning with encoders and also with different numbers of CNN layers. The system showed good performance with CNN algorithm with three layers.

Portable traffic prediction through Wi-Fi channel state information was studied in [2]. The work has taken OFDM orthogonal frequency division multiplexing to receive WIFI carriers' information. When the vehicles passed, it received information; this is classified as five vehicle types like bike, car, truck etc. The input CSI information is reduced using PCA.

Analysis and trained using CNN algorithm for classification. The results showed a good classification accuracy using CSI information gathered from WIFI.

In [3] traffic monitoring is used to classify vehicles, the study covered three types of vehicle classification in road based, over road based and side road based. Vibration based and magnetic sensor-based detection were analyzed. Similarly, on road-based detection such as surveillance detection through camera by various machine learning methods including SVM and GMM models were studied. The methods of detection on the side of the road, such as light detection and range, radar, and WIFI, were investigated. The survey concluded with analysis that a large set of labeled datasets is required, which can be achieved by closed loop self-learning. Traffic light control based on Q-learning was proposed, to reduce time delay and to set the signal wait time properly, Q - learning was used [4]. Neural network-based learning satisfied the condition of optimal delay and automated learning. The proposed method provides reduced delay on intersections.

Traffic prediction based on Recurrent neural networks was studied in [5], in a specific Gated Recurrent unit, which achieved high accuracy on prediction. Data traffic matrix considered for seven months, artificial neural network is used to train the model and evaluation automatic model is used for evaluation of the model. Resource allocation handle in this model is efficient.

Traffic prediction in intra- data center networks using auto regressive models is arrived at by author [6]. A hybrid model NARNN is a nonlinear autoregressive neural network. The author implemented recurrent neural networks and also in feed forward neural networks. By comparing both models, FNN has shown a better performance than RNN model, due to the reason that forecast error is propagated and considered to reduce on the learning phase in FNN. The input pattern is given from chaotic maps, the model tested with 600 epochs. This approach, on the other hand, can only forecast and predict significant traffic.

Traffic analysis and prediction through machine learning techniques was proposed by the author in [7]. The study employed the US traffic data 2015 dataset, which includes parameters such as route type (rural or urban), station id, state, direction, latitude, and longitude. Regression methods such as SVM regression, Random Forest regression and decision tree regression were used for implementation. The machine learning model was built using the optimized features, and the testing revealed that the computed MSE error for the Random Forest model is lower.

Traffic speed prediction by long short-term memory - neural network was proposed in [8], the dataset collected from Manchester, UK. There are two types of models discussed: parametric and non-parametric. Under the parametric model, the algorithm used is ARIMA, in which the traffic state is considered as stationary. Under a non-parametric approach, the algorithm used is ANN and no assumption is made for learning data. The LSTM-NN is shown as below model is experimented on with different parameters to learn and predict and achieve less error. There were many studies carried on this area, traffic prediction is one challenging area for researchers. Handling large amounts of dataset and learning them effectively through algorithms is challenging. The existing works have studied effectively in this area and attained good results. None of them, however, has divided road traffic congestion into different classifications or predicted accidents. The proposed system achieves this by applying CNN algorithm.

III. PROPOSED WORK

The proposed work, traffic congestion detection from surveillance image dataset using deep learning algorithm is implemented with following methodologies 1. Dataset collection 2. Image pre-processing, 3. Training using Convolutional Neural Networks and 4. Recognition of output.

A. DATASET COLLECTION

The surveillance images will be collected in 4 categories of images collected. The class data result of images is given along with a dataset picture collection. Data collection pertaining to 4 types names said in above and every class type contains nearly 900 untrained images to produce 300 of trained images for processing the trained data name itself represents the class value for classification output. The sample dataset visualization

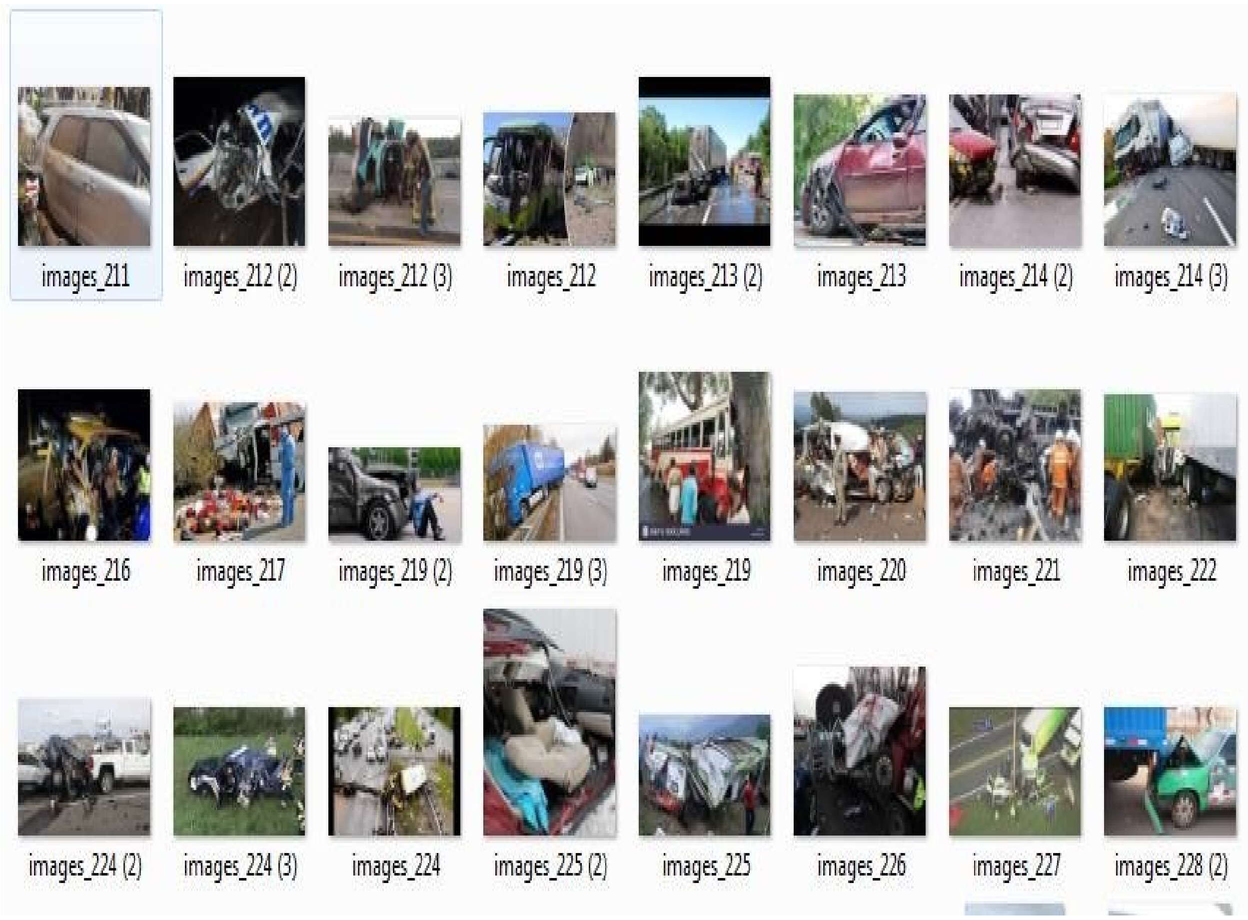

FIGURE 2: ACCIDENT IMAGES DATASET

The following image shows the heavy traffic dataset

FIGURE3: HEAVY TRAFFIC IMAGES DATASET

The below figure shows the dataset with fire accident images

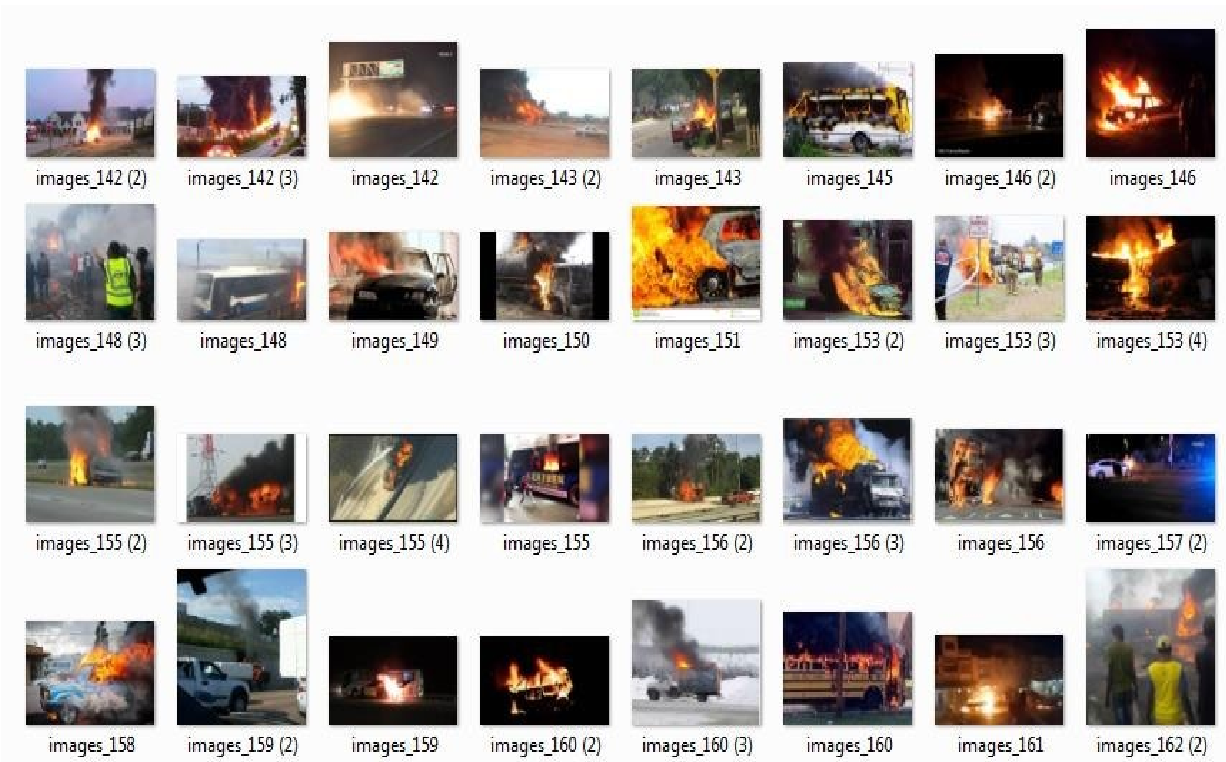

FIGURE 4: FIRE ACCIDENT IMAGES DATASET

The following figure shows the dataset with less traffic

FIGURE5: LESS TRAFFIC IMAGES DATASET

Conv2D layer is used with two hidden layers and in each hidden layer 256 dense neurons were used. **All these were** multiplied with random weights. Convolutional Neural Networks (CNN) model with Relu Optimization was used in the model. In hidden layer one, the number of convolutional kernels used is 32 and in hidden layer two, the number of convolutional kernels used is 64. The layer used a learning rate of 0.004. The below table shows the parameters used for CNN algorithm as input mentioned in table1. The methodology followed on implementation of Traffic congestion includes dataset collection, splitting into train and test, CNN is applied as per above design the model is trained. To the trained model, image or video is given as input for traffic congestion classification. The following image shows the overall architecture of proposed work

TABLE 1: LAYER SUMMARY

Layer Operation	No. of feature images	Feature map size	Validation images
Conv2D	900	150 x 150	300

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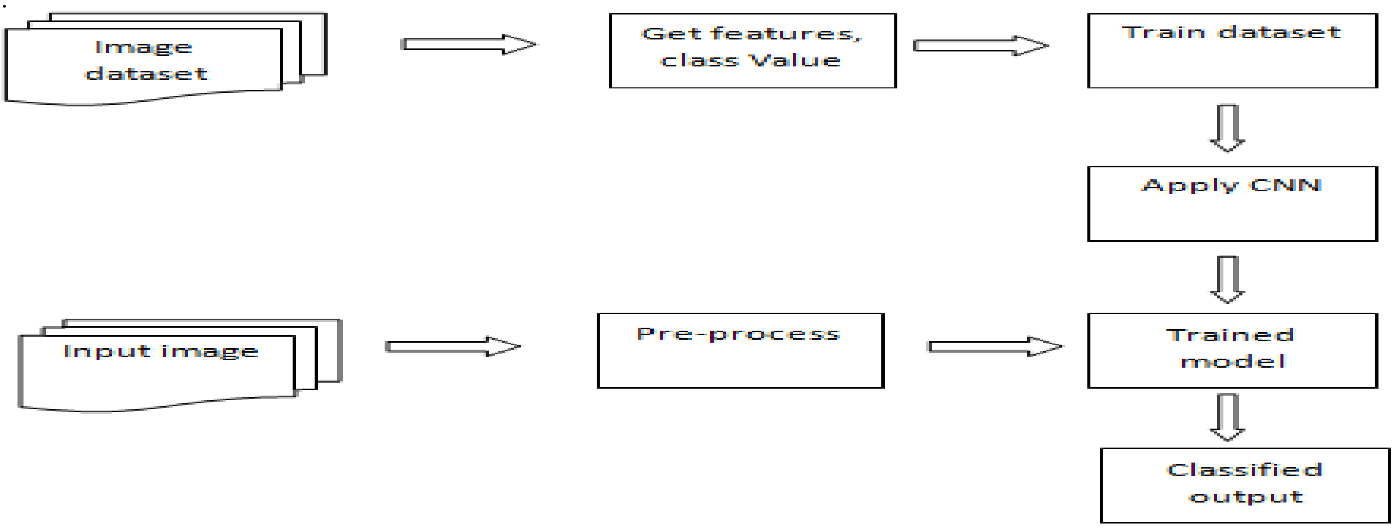

FIGURE 6: OVERALL ARCHITECTURE OF TRAFFIC CONGESTION PREDICTION

In convolutional layers, each input neuron in the hidden layer is connected to each output neuron. Thus, the network created is a fully connected hidden layer. Convolutional layers used here extract the features from input images and pass them to the input neuron. The CNN layer used for implementation is depicted as follows.

The CNN algorithm operates like this:

- s input layer, a 150 by 150-pixel image is provided.
- In hidden layer, we choose to give kernel size 5x5 moving Window, Activation function used here is 'Relu'
- In the convolution and max pooling layer, input batch size is 28x28 and 32 is the number of output channels produced

The trained CNN model has generated model.h5 and weight.h5 files. These files can be used for real time detection of traffic from images and videos. The input image is pre-processed to convert into NumPy values and given to predict function. The output classified is Heavy traffic, less traffic, Fire Accident, Road Accident as four classes. Though the multi-class classification is done, the results are highly accurate.

The proposed traffic congestion prediction is implemented in Python 3.6.4 with deep learning libraries Keras and Tensor Flow and other necessary libraries such as Open CV and matplotlib were used. Dataset used 900 images in each class with 4 classes. Training dataset 80% considered and 20% considered as test dataset. CNN is applied and builds a training model. The application is designed in TKinter, where users can give input of images to classify and get results. Similarly, users can give input of a video file, which in-turn split into image

FIGURE7: CNN PREDICTED RESULTS AS ACCIDENT

FIGURE 8: CNN PREDICTED RESULTS AS HEAVY TRAFFIC

Frames and classified and results were given to the user. For video, we considered 25 frames per second and these frames are processed for detection of traffic congestion. The output on each frame is identified and the output video is compiled as given as output to the user. The following screen shows the application front end designed in TKinter for implementation.

The following images show the output of classified images as accident by the trained CNN algorithm. Above images show the output of classified images as Heavy Traffic predicted by the trained CNN algorithm.

IV. RESULTS & DISCUSSIONS

Python 3.6 is used in the implementation with Keras and Tensor flow libraries for deep learning implementation .A new Tensor flow environment and named it 'tf'. Convolutional Neural Network algorithm is used for training. The experiment uses input parameters described in "Detailed design" and 900 photos in total for each class to generate trained dataset. The CNN model can accept surveillance images can be processed to generate trained model our model is tested against input of 300 traffic trained images from 900 untrained images in each class. The experimental result shows that our model achieves around 80% of accuracy. We have used an epoch 20, the accuracy increased with the number of epochs. The following table shows the accuracy arrived at in our experimental study. The table clearly shows that when the number of epochs is increased from 5 to 20, the accuracy improves

TABLE 2: EXPERIMENTAL ANALYSIS

Epoch	**Accuracy**
5	68.50
10	72.50
15	75.40
20	79.50

The following figure shows the model loss (Mean Square error MSE) arrived at by the CNN algorithm for training and validation dataset with 20 epochs. It is observed from the figure, that the loss value is reduced when the number of epochs is increased. The CNN model for the training and validation dataset with 20. The Below figure, Figure 11, shows the accuracy arrived from epoch.

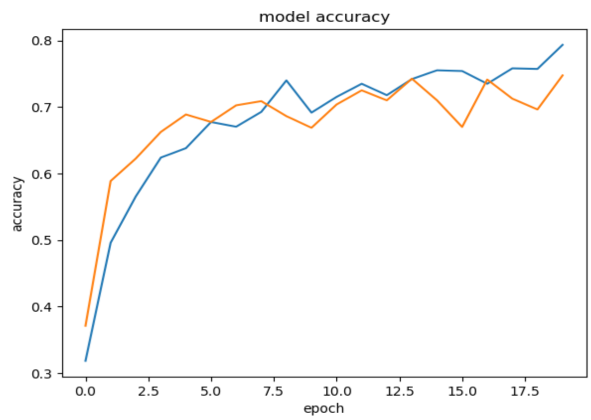

FIGURE 9: CNN MODEL LOSS FOR TRAINING AND VALIDATION SET

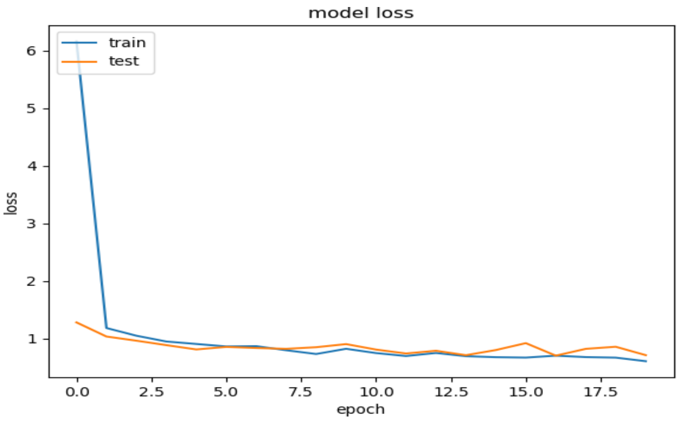

FIGURE 10. CNN MODEL LOSS FOR TRAINING AND VALIDATION SETS

V. CONCLUSION

The automated traffic surveillance monitoring system is regarded as a significant issue, and it has been solved by using a deep learning CNN model. The dataset collected on four different classes are trained with CNN and heavy traffic or less traffic is identified by the trained model. Deep learning has the advantages of learning features effectively, thus it can be applied in transport congestion detections.

In the future enhancement, it may have to take videos of the surveillance to process in detection of traffic conditions in place of traffic images. It can be happened by using video partitioned techniques and find the traffic condition on every frame. Real time traffic detection on video is quite important research for developing countries like India..

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